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SIR EDWARD CHARLES BUCK, K.C.S.I.

In Memoriam.

Sir Edward Charles Buck, K.C.S.I.

In the early days of July intimation reached Simla that Sir Edward Buck had died in Rome where he was attending the meetings of the International Institute of Agriculture as representative of Great Britain and India. Thus did the veteran end his days as he would have wished, faithful to the trust which he made his own nigh fifty years ago.

The name of Sir Edward Buck will always be associated with the establishment of an agricultural policy for India. He may not have had that close association with agricultural experiment which has become the feature of more recent years. But he laid the broad lines of principle on which have been built up our Agriculture, Settlements and Land Records, Statistics and Famine Relief, and he is responsible for the sound foundation upon which the general revenue system of the Indian Empire rests. It was not his to see the later fruition of his efforts in the great expansion of agricultural investigation which came with Lord Curzon's Government, for he retired from the service in 1897; but to the end he kept in touch with its activities, and nearly every year personally saw its progress in his loved Provinces of Agra and Oudh.

Sir Edward Buck was a great personality, full of ideas and of extraordinary singleness of purpose. His whole career was devoted to Revenue from the days that he arrived in the North-West Provinces as an Assistant Collector in 1862 till he retired, after 15 years' service in the Government of India, in 1897. In his retirement he still kept up his interest in India and its problems, and his name will always be held in affectionate remembrance not only by the hosts of Europeans and Indians who enjoyed his personal friendship, but also by all who have at heart the real development of India. He was "a very perfect gentle Knight" and his memory will for long remain green. May he rest in peace!

EDITORIAL.

With the next issue of this Journal we shall introduce certain changes which we trust will tend to popularize it. Through the eleven years of its existence the Journal has maintained the high standard of excellence with which it started. That standard, it is hoped, will be continued; but there is a feeling that the Journal might, without detriment to its traditions, be made of more general and popular interest. While therefore it will contain, as in the past, articles on specific agricultural and scientific questions, an attempt will be made to widen its scope so that it will be more the Journal of the Agricultural Departments and of the agricultural workers of India.

We shall therefore welcome contributions from all who are interested in Agricultural and Veterinary matters, Irrigation problems, Co-operation and Agricultural Economics and, in particular, from those who have the practical problems of agriculture to face—the Planting Community and the large Zemindars of India. To them our columns will always be open, and we shall welcome all enquiries or criticisms they may address to us.

On this broader basis we trust that the Journal will enter upon an era of increased popularity and prosperity.

THE CONTROL OF FLIES AND VERMIN IN MESOPOTAMIA.

BY

H. MAXWELL-LEFROY, M.A., F.E.S., F.Z.S.,
Lately Entomologist in the Imperial Department of Agriculture for India.

[We have much pleasure in publishing this article from the pen of our former colleague Prof. Maxwell-Lefroy.

The Indian Agricultural Service—both European and Indian—has responded nobly to the Nation's call and our best wishes follow the present detachment of eight Pusa Assistants who have volunteered for service in Mesopotamia. May much success attend their efforts to alleviate the conditions in which our gallant troops are living, and may they return safe and sound, with the consciousness of a duty well performed.—(*Editor.*)]

There have been urgent reasons for dealing with flies and vermin among the forces in Mesopotamia this year, and I was fortunate in being sent up at the end of April to investigate and decide what could be done. Even on the way up, there was entomological work to do. The hospital ship on which I travelled from Bombay had been long in the tropics and was full of small red ants which were a sore trouble to the wounded and sometimes worse. As the ship was going up empty, there was full scope for work and after failing with one method, we succeeded with another. Baits were put down (usually syrup on rags) and the trail of ants to the nest traced back. The nests are all behind wood-casings and the cracks of exit were oiled with a mixture of paraffin and lubricating oil. This isolates the nest inside with the queens and the workers outside cannot bring food in. In three days there were no more trails or nests discoverable and the plague was under control.

Basrah was hot and stuffy but not markedly plagued with flies; but as one goes up river it gets worse at every camp till the climax is reached at the most advanced post where Corps Head-quarters are situated. The flies are mostly the Housefly type, *Musca*, of several species probably, a few Blow flies of the *Calliphora* type, and some *Stomoxys*. The last is a nuisance on the river as it bites so sharply but it is not a disease-carrier and is not really common on land.

To fully appreciate it the abundance of flies has to be seen and still more to be suffered. The tents and trenches are full of them. By night they sleep in masses on tent roofs, etc., in the morning they awake to furious activity as soon as the sun has warmed them, till midday they feed and fly and buzz; then they seek deep cool shelter if it is hot, say over 110° F. in the tent, and go to sleep. In my tent they preferred to get under the bed on the sides of the pit in which one lives. At evening they start again and are very active from 5 to 7. When one has been driven crazy, it is good to go and see the patient resignation of the sick and wounded and therefrom to learn control and resolve more strenuously to destroy the scourge. And then one remembers that nearly every disease in Mesopotamia is one that is carried by water and flies only, and one realizes that the fly is really a serious factor in this campaign.

Another entomological problem is of some importance in Mesopotamia, and this is the control of vermin and sand-flies, fortunately no difficult matter. The former convey relapsing fever and typhus, the latter carry sand-fly fever; both are the cause of irritation, the sand-fly especially; there have been cases of serious septic sores from sand-fly bites and the sand-fly has been one of the real plagues of life. Fortunately there is a cure for both. In 1904, the use of Crude Oil Emulsion was first introduced by the Entomological Section for vermin on animals; early in 1915, a refined form of this was shown to the War Office, and in May was adopted as the official vermin remedy for the army. It is now being made in large quantities in Bombay and sent up to Mesopotamia. In the Army it is known as " Vermijelli," but as this is a registered name, the property of a firm in London, it is called "Sand-fly and Vermin Ointment." It has the merit of keeping off sand-flies and mosquitos, if rubbed very lightly on the hands and face. I had one tube with me in Mesopotamia. I did not realize the sand-fly was there and was badly bitten the first night; I was never bitten again, I used no net and all who shared my tube found the same. It is now being issued for this purpose. For vermin the emulsion is rubbed on the hairy parts of the body and on the seams of clothing; under-clothes are washed with it and dried without rinsing so that the clothes are lightly impregnated with it.

With regard to flies there are really three problems in Mesopotamia, the control of flies in camps, trenches, etc., in towns and with moving bodies of troops. The first is the important one because it is the biggest and, in some ways, the easiest to deal with. The breeding places in camps, trenches, etc., are of three kinds. The latrine trench is far the worst, accounting for probably 90 per cent. of the flies; the accumulations of stable manure, and the accumulations of refuse and offal account for the rest. The latrine trenches are about 18 inches deep, a foot long, six inches across; a series are dug side by side, according to the number of men. They are filled up daily. They offer the ideal breeding place for flies and they swarm with flies laying eggs when they are in use and are solid masses of maggots in a few days. Flies emerge from trenching ground in hordes, get their first meal at the nearest trench then in use and then distribute themselves over the camp.

Stable manure was comparatively harmless owing to rapid desiccation; only when small amounts were swept up with dry litter and so preserved from drying did one find maggots and the manure is nearly all dried and burnt. Kitchen refuse and offal are usually burnt or buried but would easily breed flies. The greatest care is usually taken and it is only carelessness on the part of the sweepers or camp cleaners that allows this material to breed flies.

In most places in Mesopotamia there is absolutely no other source of fly breeding; the land is flat, dry, absolutely barren as a rule; there is no shade, a fierce sun bakes it, a dry wind blows furiously. Only where man is, can there be shelter, food or breeding places and there is no man but soldiers in the war area. There are stories of bodies of men trekking into the bare open country, and finding hordes of flies, but they took these with them. When one comes out of the trenches, flies settle on all the areas shaded by one's *topee* or oneself and on all the shady parts of one's horse; they travel on one thus for miles, unable to fly away in the fierce sun. In this way one carries swarms of flies and a body of men, when they camp, will naturally find their tents full of flies.

No place strikes one as so easy to clear of flies as a camp, as all is done in full view, there is nothing hidden and one can control everything. There are no houses, no back-gardens or filthy alleys, no refuse dumps or collections of rubbish. It is a matter of deciding what to do and having it done.

The second problem will be more difficult because it is not so easy to control a town. In Basrah and Amarah there are large areas of camps, with streets of houses not far off; the problem is not so simple because of the uncontrolled breeding places of the native houses, and it is more a question of extensive fly killing (as described below) than of prevention.

The third problem again is difficult because of the limited resources of a moving body of men. Such a body of men will not suffer from the flies they breed; they suffer from the flies bred by other moving forces before them and there are camping grounds on lines of communication where you arrive to find that swarms of flies greet you and millions are then emerging; that means that ten days before a body of men camped there, used latrine trenches, and probably did not trouble too much about the disposal of kitchen refuse and offal.

Having examined the problem and especially having seen what was needed for the trenches, the field hospitals and the head-quarters and other camps, it was a question of getting supplies and a staff of men to carry out the obvious measures. All the supplies that went with me from Bombay were snapped up at once and much more was needed. Everyone in charge of hospitals particularly needed help and supplies; it is a real experience to go round the tents of a cholera or ordinary hospital, and to see what a curse the flies are to the men. Then one sees the operating tent and realizes that flies may come 100 yards from a nearby latrine to vomit their last food on the exposed tissues of a patient; one sees flies settling on a fresh wound, and the men fighting them off while it is dressed. No wonder every single person is keen to help the fly campaign and that every possible assistance is being given to those who are trying to reduce this pest.

A short simple set of instructions was prepared and issued; the measures recommended are discussed here in turn.

1. As far as possible, replace latrine trenches by tins and incinerate. This system is very widely used: tins are sunk in the ground to receive fæces; nearby is a small round incinerator consisting of a circular wall three feet high with a grating across of iron rods and two air inlets below; dry litter and any dry material is put in, lit and it burns slowly; on this the material is incinerated. This is not always possible particularly in the trenches; but one battalion had an incinerator for its front line latrine: and where this can be done it is the proper thing.

2. Where incineration is impossible and deep trenching is impossible, then each latrine trench must be treated. After trying pesterine and fuel oil without effect, it was found that ordinary burning oil, as issued there, was effective; a trench treated with oil does not get infected with maggots and if oiled when it is filled up, many maggots are killed. There is much oil available, the crude lighting oil of the Anglo-Persian Oil Co., obtainable near Basrah, being quite suitable.

3. Oil should be used even with tins as it prevents flies settling and feeding on the excreta. A great deal of the diarrhœa and intestinal diseases prevalent must be carried by flies directly from the fæces of infected men and oiling prevents that.

4. Kitchen refuse and offal are to be burned or oiled and buried. This is obvious and is rendered more important by the fact that a great many goats are slaughtered by native regiments, in their own way, anywhere near their lines. There is a great deal of indiscriminate goat-killing going on wherever there are native

units and this material would breed flies. The absence of blue-bottles shows how careful the men are in this matter.

5. Horse and mule droppings are to be collected and burned or spread out to dry. As a rule the droppings are wanted for the incinerators. The heat and dryness are such that in a very short time, house manure is too dry for flies to breed in it; the only trouble has been with the individual *saises* of officers' horses who may be careless and breed a quantity of flies; where there are regular horse or mule lines the greatest care is taken.

6. Trial of fly poisoning with sodium arsenite showed it to be an extremely effective method; fortunately I had been able in Bombay to get 50 tins of weed killer, which was crude arsenite and worked very well.

A mixture is made of arsenite half a pound, *gur* two and a half pounds; water two and a half gallons. This is a convenient amount for a kerosine tin. In this a gunny bag was dipped and hung up. A shelter tent or a covering of mats is advisable or the flies will not come in the hot part of the day, and the gunny bag must be kept moist. Flies come in swarms, feed and die there on the spot. The solution is weak enough not to affect them till they have fed; if made too strong, they are affected before they get a fatal dose. It is possible to fit up strips of gunny on the roller towel principle so that it dips in the tin; as it dries and gets too concentrated water is added.

This simple poison, devised originally by Dr. Berlese of Portici, Italy, works beautifully; the flies are thirsty and hungry; they smell the *gur*, they come in shoals; blue-bottles come as well as *Musca*. The slaughter is very great and the effective range appears to be at least 200 yards and is probably much more. This means that to keep a camp clear one wants a fly-poisoning station every quarter of a mile or so. By having the poisoning done in a separate place there is no risk from dead flies and it is best to put the poison at a point between the latrines and the camp.

7. In the trenches flies collect in masses at certain places at night and at midday. They particularly like canvas or tarpaulin coverings and sheltered corners in dug-outs. With a spraying

machine and suitable liquid, one can kill flies in bulk. The choice of liquid is easy; two only are at present known, both of which have been extensively used in Europe and Egypt since they were discovered last year. For the trenches we are using the oil-spray, a special grade of mineral oil to which is added a small amount of aromatic essential oil such as citrovella. In England, this is sold as "Flybane"; in Bombay, thanks to the help of the managers of the Standard, Vacuum and Asiatic Oil Companies, the nearest grade of oil to that selected in England has been found and is being used.

8. Hospital tents and buildings require other methods. Formaline can be used for fly poisoning; but the "Miscible fly spray" used in Europe and Egypt will probably give the best results; it is undesirable to use the oil as it taints milk and food; but this new fly spray, whose laboratory name is *Exol*, is being sent up for hospital use. It is not poisonous or inflammable and has only a slight smell; it does not taint food. It is mixed with water and sprayed in the air. Flies fall to the ground paralysed or dead. It is not yet certain whether the formula used in Europe will succeed in Mesopotamia owing to the very high temperatures but this has to be ascertained and the formula varied if necessary. Thanks to the Medical Store-keeper at Bombay, large quantities of this have been made. At the request of the War Office the formula of this spray has not been published as the ingredients are not unlimited in supply. When the Army has had all it needs, the formula will be published and the public can get the liquid.

For hospitals, an ample supply of netting, mosquito nets, etc., has been essential. It is absolutely necessary to prevent flies getting at the excreta of cholera or dysentery patients for instance and in tents this is only possible with nets. In the same way the disposal of the excreta is very important and all field hospitals use incinerators.

A special problem arises in the case of bodies of men moving. I believe that it is better in these cases to have no trench latrines, but to mark off a space of clean and hard ground and use that. The heat and dryness is such that flies cannot breed in the material which desiccates at once. This goes against the sanitary expert's ideas but I believe it to be sound in all cases where the moving body is not going to stay more than three days.

These are the methods recommended and the three important ones are—

(1) Disposal of fly-breeding material.
(2) Fly poisoning.
(3) Fly spraying in trenches and hospitals.

It was obvious that to carry these out there should be a special subordinate officer attached to each large camp and to each division. He would naturally be under the orders of the Sanitary Officer but his special business would be flies. He would inspect the whole of the camp or the trenches occupied by his division, hunt out fly-breeding material, report cases of bad sanitation, see that latrines are oiled. He would be in charge of the fly poisoning, he would show men how to use sprayers and organize a gang to systematically slaughter flies with sprayers.

Such work is best done by men used to spraying and similar operations. Eight were required for the different places in Mesopotamia and I proposed going to Pusa for them, taking volunteers from the Imperial Pathological Entomologist's Section, as flies have been their business for years, and also from other sections, or from Provincial Departments if necessary.

Captain C. F. C. Beeson, Imperial Forest Zoologist, who was with me in Mesopotamia, remained there and would be in charge of these men and the whole work.

This proposal was accepted and I returned to India to organize supplies of arsenic, sprayers, etc., and to get eight men. The selected men are shown in the photograph which accompanies this article. They left Pusa on Wednesday, July 5th, for Bombay whence they proceeded to Basrah and Amarah. They were recruited from the entomological and mycological sections with one from the veterinary staff. They have rank as Indian Warrant Officers according to their pay and will be on duty in Mesopotamia probably till October. In the first place they join Captain Beeson to get experience of military conditions and then they will be posted out.

The Agricultural and the Forest Research Institutes are to be congratulated on supplying the officers and staff for this work. No one anticipated that the work of the entomological sections would be of vital use in this war, and it is a satisfaction that the work done years ago in the Imperial Department has been of direct use and that the men and methods can be supplied for the present campaign. Their work will be very much appreciated in Mesopotamia and we hope all will return well with a successful piece of work well done.

AGRICULTURAL EDUCATION.

BY

WYNNE SAYER, B.A.,

Assistant to the Agricultural Adviser to the Government of India.

I. INTRODUCTION.

ON the subject of agricultural education much has been said, many methods put forward and as many condemned, and a great deal of the discussion has been at a loose end. A partial acquaintance with a great many different systems and methods used and employed in the furtherance of agricultural education in the United States of America, Japan, Germany, England, etc., will suffice to show that the subject is a complex one requiring close consideration.

An examination of the different methods employed in different countries leaves one with a definite substratum of general principles which we may try to adapt to our local conditions. The first efforts will of necessity be largely experimental, but from the experience thus gained we can go on making changes in our system as they are proved necessary; we have therefore to learn a lot before we can hope to arrive at any semblance of finality in our system of agricultural education, and this should be taken for granted by all parties concerned. As things stand at present we have three classes of people to educate, each of whom, in his own way, influences agriculture:—

First—The ryot, on his own land. He represents present agriculture in the active sense.

Second—His children who represent the active agriculture of the future, both workers and teachers.

Third—The landowning class, whose influence on agriculture is of the greatest value when properly applied and whose sympathy and interest can assist in the propagation of sound agricultural practices all over India.

These three classes linked in a proper appreciation of improved agriculture and its possibilities could create a new India and they wait on agricultural education to show them the way.

II. DEVELOPMENT OF ENGLISH EDUCATION IN THIS COUNTRY.

It will be well to take a cursory glance at the development of general education in this country before proceeding to the question of agricultural education, as it will enable us to better understand what effect it has had in the community and how it has affected agriculture. It was after Lord Macaulay's famous Minute of 1835 that the Government of India definitely decided in favour of English education. Education on Western lines was in fact becoming necessary as there was a growing demand for it. Another forcible reason was that as Government was settling down to administer and consolidate its possessions in India it required public servants with a knowledge of English to help its European officers in carrying on the work, getting into touch with and making its intentions known to, the people.

The Universities of Bombay, Madras, and Calcutta were established in 1857, the Universities of the Punjab and Allahabad being founded in 1882 and 1887 respectively. As science was not so well advanced in those days, the education in India promoted by these Universities came to be more literary than scientific.

The English system of administration with its regular supervision of every detail and its foresight required a larger number of subordinate agents than was required in previous indigenous administrations.

Indian administrations in many cases under-paid their staff and winked at their recouping themselves—the natural result of under-payment.

The British system *gives* what is considered to be *sufficient* pay to remove any necessity for corruption. Thus those who received an English education got a large increase of pay compared with what they were used to under Indian administrations.

This acted as a great stimulus to Indians to seek an English education. It was regarded as a royal road to fortune and rightly so.

There was also a great demand for lawyers and pleaders consequent upon the fact that it was necessary to reduce the chaotic condition of the Indian administration, notably as regards land tenure and ownership to a definite legal status.

Further the opening of railways and the establishing of cotton mills and other industries provided employment for those who were only half-educated, or rather not up to the standard required for Government service and the law.

Thus the stream steadily began to flow in one direction and the effect spread to the remotest corners of the land and having saturated the minds of all and sundry it became a fixed belief. Hence there is stamped on the life of India one great goal, an English education followed by a Government billet.

There was an idea that the educated class would disseminate what is best in Western literature and science to their more backward brothers through the medium of the vernaculars, but this pious wish has more or less fallen flat.

Railways, irrigation works, Public Works Department, and factories have provided employment for numerous artisans, and from this the idea has grown up in a large section of the literary and agricultural classes that to stop in your village means starvation unless you have a large holding.

All this was brought about by a condition of things which could only be a transitory one based as it was purely on an artificial demand.

The tide still sets the same way, but the opportunities are now far fewer. The craving for education remains the same, and probably always will remain, but it is high time to see what we can do to divert it into more productive channels.\ It was towards the end of the nineteenth century that the Indian Government began to think that all branches of education required careful review, and the Universities Commission immediately followed. Since then Government has leaned towards an education less literary and more practical, and in many Universities the courses have been altered to keep that end in view.

III. Agricultural Colleges.

It will thus be seen that the craving for literary education exists in the literate classes and in the more influential and higher agricultural classes. It is these classes who are ready to take advantage of scientific education in agriculture.

It was at first thought that no higher agricultural education would be necessary beyond such as would enable those who had received the two years' course in agricultural schools to make efficient subordinates under expert officers and to make those who did not enter Government service into better farmers.

Agricultural colleges of the advanced type we have at present in India came with the development of the Agricultural Department, the idea being that as agriculture is the backbone of Indian prosperity we cannot give too much agricultural education in this country ; while therefore preference was to be given to boys who were brought up amidst agricultural surroundings : yet these colleges were to be open to such boys of the non-cultivating classes as might have a leaning towards agriculture. In the initial stages in order to attract students for these colleges Mr. Mollison, Inspector-General of Agriculture in India, was in favour of putting a leavening of agriculturally trained men into the Revenue Department on the ground that it is the subordinates of the Revenue Department who really see the agriculture of the land and who on account of their knowledge of the economic condition of cultivators can help forward the work of the Agricultural Department—a thoroughly sound view for many reasons which might well have been developed.

With regard to agricultural colleges at the present time it is as well to make one point clear which is apparently misunderstood.

in some quarters that they are not intended merely to supply subordinates for the Agricultural Department, but to provide a liberal and scientific education in agriculture for those who either aim at higher appointments in the Agricultural Department or desire to take up higher studies and research work in agriculture for their own sake. In many European countries there is an agricultural faculty on the lines of other faculties in the Universities, giving liberal scientific education in agriculture and sciences allied thereto and training men for research work. In these no training in actual agricultural operations is given as the object is to turn out specialists fitted to carry on independent investigations. These faculties provide liberal scientific education in agriculture and thus attract the very best talent. **We think that in India also for the general widening of agricultural education affiliation to a University is desirable.** So long as agricultural colleges are not affiliated to a University they will not attract boys from the higher classes of Indian society connected with the land. These classes require a true collegiate education centring round agriculture, not mere manual training in the details of each agricultural practice. When these facilities are provided a fair number from these classes will be forthcoming, and the men thus trained will take their places as leaders of rural society with a thorough knowledge of what to aim at in the development of their estates. The strength of English agriculture lies in the fact that practically every land-owning Englishman has a knowledge of farming and stock-breeding—it is part of his life; *noblesse oblige* is the reason for it and the fact is recognized from the King downwards. Thus it can be seen that this class furnishes the country with a set of pioneers and influential supporters in agricultural improvement; and India wants a similar class. It is unnecessary to lay down that they should go through the same courses as those intended for the subordinates of Agricultural Department. What is wanted is to enlist their sympathies by giving them an insight into the subject and to make them able to realize the value of research and experiment; to make them see that to better the condition of their ryots is to their own advantage as well; to turn them from supercilious onlookers into sympathetic co-adjutors of the Department; and for this it is necessary to create a strong faculty of agriculture at the University. One Agricultural college affiliated to a University will meet the needs of Peninsular, and another Northern, India: for the class of men they are intended for will not require a college at their gates. They will go to the two colleges in the same way as land-owning England goes to Oxford and Cambridge. The rest of the colleges might be turned into agricultural high schools of the type prevailing in America, or agricultural schools in Germany or Switzerland and will cater for the needs of the Agricultural Department in providing recruits for subordinate posts.

IV. EDUCATION OF GROWN-UP FARMERS.

The provision of agricultural colleges does not complete the scheme. As the cultivators are mostly illiterate they do not value a scientific education and in order to make them value this for their sons we have to show them what agriculture on improved lines can do in the amelioration of their material condition, *i.e.*, we must convince the father in the only way in which he can be thoroughly convinced, *i.e.*, by practical demonstration. Demonstrations should be given on Government farms, at the cultivators' own homes, or at any convenient place, together with short courses on special subjects and it is here that the subordinates of the Revenue Department if they had an agricultural training could help best. So long as the agricultural classes are in the backward condition they are now, demonstration must go to them. They cannot be expected to spend time or money to any extent coming to it.

In India the system of caste has given the cultivator centuries of traditional experience behind his back. He knows to an inch what he can do with the limited amount he has to hand. We have therefore to be careful not to disturb this economic balance by an improvement which may be excellent but which would not work here, and it is the study of this economic balance both in this and in other greater and wider directions which is becoming a grave necessity, and which I hope to deal with later.

We are constantly reminded forcibly by print and illustration of the wonderful improvements brought about in other countries but this should be remembered that the introduction of improvements in Australia, Canada, and the United States is brought by capital. People who have little or no experience comparatively of the land they own, will always imagine a new thing to be much better than it is. They will risk more. They are new men in a new land. They have experienced few of the set-backs incidental to agriculture, and their hopes are correspondingly higher. Here in India it requires a strong man to introduce an improvement; it has to be a very strongly marked improvement if it is to be adopted by the ryot; India has a rooted conservatism which cannot be realized by the countries like the above.

Again it is useless to blame the Indian farmer for adopting a policy of backing two horses in his farming. He grows two crops on one field; why ? because he is not sure of the rains. Whatever happens he wins out on one and saves himself from starvation. The net yield of either crop, which is of course small, may be held up as a scandal by an expert who has never been in danger of starvation—but it is rare to find gross carelessness or gross neglect. The lives of too many depend on that crop—and that is the reason for the margin of safety so easy to refer to as wasted opportunity but so difficult to do without in the present day.

This then is the position. We can hardly teach the ryot his own job if we are limited to his circumstances. I venture to say no one can, but let me not be misunderstood. Agricultural Departments can open the gate to greater things by virtue of money. All improvements require capital. It is no use telling the ryot to do his own experiments—he cannot; his margin is too small but the Agricultural Department can do this by finding the capital for them. It is possible to bring an improvement within his reach when arrangements have been made for financing him so that he can safely take it up. To educate a man at an agricultural college and to send him back to work on a farm with no capital is useless. It may sound well to say he has been educated, but the effects will be nil.

The application of scientific knowledge to Indian agriculture opens out a vast field for increasing the out-turn of crops in India, *e.g.*, the yield of rice per acre in India is only about ⅛ of that in Spain, that of wheat is about ⅓ of the average out-turn in England, and it is only the Agricultural Department which has the capital, science, and skill that can undertake experiments for increasing the yield. A long series of tests is necessary before any definite agricultural improvement can be recommended for adoption, for jumping at conclusions to make a show and a splash in a country like India is fatal; time here is no object, to-morrow is also a day. Sooner or later the part that has been missed—slurred over, written away will be found out and a deep-rooted mistrust will oust the slow-grown confidence in the Department as a whole.

Now turning to the subject of demonstration as a method of education, while the evolution of new types and the replacing of inferior kinds by superior varieties are very promising lines of agricultural improvement in this country they will take time. We also realize that research must precede demonstration, but in the unequal agricultural progress of the cultivating classes in India there are many good practices which are known in one part and not in others. These require to be brought to the notice of more backward tracts. It will thus be seen that the greatest and the most immediately remunerative work lying ready to hand is not the introduction of some scheme requiring extensive, expensive machinery from abroad. It is the quiet, systematic transfer of the best agricultural practices from one province to another, from one district to another. The transplantation of rice seedlings known for years, nay, ages in many parts, was unknown in Chhattisgarh and there now ranks as the greatest improvement and rightly so. And it is here that the Agricultural Department has done wonders at a trifling cost, to quote but one instance. Such improvements impress the ryots, create in them an enthusiasm for progressive farming, and make them see the wisdom of receiving a training which enables a man with a wider outlook to pick the brains of others and apply them to his own use; for it is through this experimental avenue that an increase of revenue will come to ryots and the State, and it, should be obvious that **this is the most paying line of policy in laying the foundation for the demand for real agricultural education, which will follow directly the ryot is convinced that there is something in it.**

As already pointed out above, agricultural improvements in most cases require capital. What is therefore wanted along with the spread of improvements is an effective method of obtaining capital, through as few intermediaries as possible, at a reasonable rate, and it is here that co-operative societies, though only in their infancy, can do most good. The passage of the money from lender to borrower *must* be simplified.

Agricultural seasons wait for no one, and to find a man, who has applied for a loan to get good seed, forced to fall back on cheap inferior stuff, owing to inability to get his loan in time, is what we want to avoid. The man who lends money on to the land must lend it when the land wants it, for the land is a bank whose doors are only open for deposits on really favourable terms for a very short time and this cannot be too strongly emphasized.

In the drier parts of India money lent to dig a well does more than this: the mere digging of it not only ensures the rains crop against possible failure, but it also encourages intensive farming and prolongs the cultivating seasons throughout the year and provides the ryot with employment for himself and family all the year round, weans him from idleness and litigation by making him live on his land. Where else does the digging of a well do all this? Certainly in no town. It is for reasons like this that the co-operative societies want more money and it should be made available to them. Every pie spent thus by a primary society will return a hundred-fold by increasing prosperity and stabilising the revenue. The successful working of these societies will raise the moral tone of the cultivators, and this in itself will produce the better, steadier, more prosperous class which it is the aim of every country to produce.

V. EDUCATION OF THE CULTIVATORS' SONS.

General observations.

What is the aim of education? It is to make the nation more fitted to take its place as a nation among other nations, to hold its own in the great economic struggles of the future, and in this coming struggle the dignity of labour will bear the brunt. Education should aim at producing a future race each better than his father at the family job and not necessarily a renegade from his ancestral profession. The present education is given totally irrespective of the parentage and of the future of the individuals : can it be wondered, then, that it all too often fails ?

While it may be admitted that some knowledge of the three R's is necessary to every man in the present stage of the evolution of the world, yet after this, specialization should commence as soon as possible, based on the needs of the man. Specialists at their best should be improvers of their fathers' work carrying on the family traditions ; one cannot emphasize too highly the fact that the national prosperity depends on the skill of its people, its varied development and not on the super-literary education of a minority. And any education, which does not go deep enough to improve the man's chances of making a living to the good of the country, is no use. A highly educated class for whose labour there is no demand can only be parasitic on the country which educated it.

Education in rural schools.

We now come to examine education as provided in rural schools.

Many people with vague notions of agricultural education often advocate that in village primary schools the Education Department should begin to teach agriculture. Let us examine what this means. In primary vernacular schools boys have to learn reading, writing, and the doing of ordinary sums in arithmetic. Nothing more can be added at that age to their syllabus. It is sometimes said while we cannot teach agriculture we should teach agricultural principles ; but it is only developed intelligence that can follow the abstract—the children should go from concrete to abstract and from practical to theoretical. To cram them with these principles without their understanding them will only produce harmful effects, which will be very hard to obliterate at school or college. What is required at primary schools is that the teaching should have more relation to the environment of the children. Text-books suitable for urban primary schools are not suitable for village schools and at present they are common. Hence children taught in village schools become rapidly divorced from their fathers' profession. In arithmetic also—teachers should deal with sums relating to payment of rent, real measurements of fields, calculation of fields' produce, etc., all things which will prove useful later on. But the difficulty is that in a large number of cases the scholars in rural primary schools are drawn from non-agricultural classes. Further, the primary schools are part of an educational ladder by which the clever boy whether from town or country can go up to the anglo-vernacular school and perhaps to a college. A different syllabus for boys in the rural school will handicap them in this respect. It will thus be seen that, while direct teaching of agriculture is to be deprecated, the giving of an agricultural tinge to the education imparted in the higher classes of these rural schools is a great desideratum, especially for those children who are not going up to the anglo-vernacular schools, and in this connection the value of nature study and school gardening cannot be over-estimated. It is the teachers who can, even with existing text-books, make the instruction suitable to the requirements of rural children. But this is where the teachers fail in a large number of cases—they miss the real point and the essential part: to sit in a class room and make remarks—is not what is needed. To go out and show the class what to observe is really what is wanted. Later on we find students lacking in observation and practical initiative and in manual skill; why? because throughout their whole training book-work has ranked highest, and it is only when they come out into the world they find that the position is reversed —much to their detriment. All over the world the cry is for skilled labour and always will be, and the man who is master of a trade is always sure of his living. It is an age of mechanism, a fact which India has not yet grasped.

Year by year the farmer becomes more of an engineer, and all trades tend to inter-connect to their mutual advantage. A big farmer with one son trained as a mechanic and one as an agriculturist is both master of his land and his implements; with the rise in wages more labour-saving implements are introduced and the rise in the price of cattle helps as well. There can be no set-back to the use of agricultural machinery now; it has shown the world what it is capable of doing and the world, after one great gasp of surprise, is hastening to take advantage of the lesson.

It is important not to stifle the would-be mechanician in early life—we all remember the fate of the boy with the mechanical mind in our public schools. He used to be regarded as a social pariah, a creature of wild mind and wilder pursuits. Now he has ousted the classical people from pride of place throughout the land and what has happened in England should guide India; for the present war has given England an enforced mechanical education, the use of which will never be forgotten by the nation—for it is not a knowledge of the classics and certainly not a knowledge of law which is beating the German.

While we note the fact that manual training is provided in some of the schools in India we wish that it may be developed more and more, not as a fashionable fad, but as a prime necessity. It is often asked why it is that in spite of India's enormous cheap labour market and its proximity to the supplies of raw material, India cannot fairly compete with other western countries. The answer is that unskilled labour though nominally cheap yet in these days of machinery is ultimately dearer. Skilled labour has to be imported at a fabulous price, for the combination of unskilled labour and expensive machinery is the most expensive thing on earth. Any one doubting this need only give a cooly a mowing machine to work for a day. The cooly costs far less than a skilled man, but the repair bill of the machine swallows up the difference and the machine wears out far quicker.

Special Vernacular Agricultural Schools.

We now come to a consideration of the question what provision should be made for the sons of agriculturists who, after completing their vernacular course, are not going up for English education, but wish to gain more useful general knowledge coupled with some instruction in agriculture. We think that in the case of these the provision of vernacular agricultural schools on the lines of that at Loni is most desirable. The boys at this age will be able to understand why certain results follow from certain causes. For the information of those of our readers who are unacquainted with this interesting experiment initiated by the Bombay Department of Agriculture we may say that the courses at Loni are of two years for boys who have passed at least the 4th Vernacular Standard, aged 13—18, 3 to 4 hours' are devoted to general education, while a similar number of hours work is done in the field. The whole of the cultivation is done by the boys and they all learn to make simple implements, the use and care of good steel implements as well as how to drive an oil engine which pumped water, bruised grain, etc. The teaching is entirely in the vernacular. As this was the first attempt of its kind board and tuition were provided free. The boys were mostly drawn from the sons of large cultivators with whom the Department was in touch though a considerable number of applicants were of the more literary class who were only admitted with great care. The boys trained at Loni have started real centres of interest in agricultural improvement on return to their own land. The success has been so gratifying that similar schools have been started in other divisions partly with Government money and partly with local subscriptions and endowments.

In starting such schools in different parts of India the exact age and educational qualifications for recruitment and the ratio between the general education and the technical education to be given at each school will have to be determined according to local conditions. But it would be well to bear in mind that practical training in each detailed piece of agricultural operations should not be considered as the only thing. What is required is to give them some knowledge of mechanical engineering and good general education with agriculture, so that the outlook of these boys may be widened and they may go away with an enthusiasm for their own calling and carry on their business in a really intelligent manner.

VI. CONCLUSION.

If a boy was made to work with his hands from the beginning he would appreciate the dignity of labour and his whole after-life would not be aimed at a position of *looking-on*. The aim is to assist a boy at his future work, not to divorce him to follow another calling.

The essential of most English engineers is the fact that they have been through the shops from the very beginning. I have known a man with a University degree who spent a month doing under-fitter's work in his father's Works. When India grasps the fact that to run a business successfully you must know the inner working of every step and detail, then we shall get captains of industry in other walks of life than money-lending and the law. Mere learning of science will not make a practical workman; it is the combination which is so strong.

Now is the time for India to make her effort. Her greatest asset is agriculture and the agriculture of the world was never so prosperous. Agricultural produce will rise in value after the war. to the benefit of India. Let her, therefore, take steps to put her chief industry on a better footing; better cultivation, better marketing arrangements, better financing of the rural population, a wider use of mechanical power is demanded. All the world is moving rapidly on the line of advance. And if India lags behind it will be a national calamity. Let her bestir herself and realize that the produce of the land is capable of a considerable amount of increase. This better state of things will be brought about by the education of the adult farmer and the rising generation who will farm when he has gone—in short by the education of India in a direction where best the talents of the nation may be fully and profitably employed to the benefit of all.

WHY ARE THE CULTIVATORS' OUT-TURNS OF WHEAT ON IRRIGATED LAND SMALL?

BY

W. ROBERTSON BROWN,

Agricultural Officer, North-West Frontier Province.

THIRTY-SIX maunds[1] per acre on two acres; twenty-eight maunds per acre on eight acres; twenty-five maunds per acre on thirty-two acres; twenty-two maunds per acre on eighteen acres; an average yield of about twenty-five maunds per acre over all these acres; these are the yields of wheat harvested at the Tarnab Agricultural Station this past May.

The average out-turn per acre on the 100,000 acres of irrigated wheat in the Peshawar District is less than twelve maunds per acre: is less in fact than half the average yield per acre over 60 acres at the Agricultural Station. Yet only 8 of the 60 acres received any manure; one-half of the area was irrigated once only; the remaining 30 acres received but two waterings; the rainfall during the period of growth was only 5·10 inches; harrowing and inter-cultivation were not practised; on three-quarters of the 60 acres wheat followed wheat; one ploughing with the Rajah, and two turnings with the country plough only were given to the land. In short, the Tarnab wheat would not appear to have received better cultivation than wheat in the neighbourhood.

Why, then, are the yields in the vicinity of Tarnab and those stated in the Season and Crop Report so very much less than the Agricultural Station out-turns?

The varieties grown at Tarnab are Pusa No. 4 and Federation, and these are noted yielders, but their superiority to local wheat in this respect will not nearly account for the out-turn of the Station being more than double that obtained by the cultivators.

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[1] A maund = 82·12 lbs.

To those who spend their lives with the cultivators on the land the enigma is made plain.

Firstly, it may be stated that the failure to produce high, or even fair, yields of wheat is rarely due to the cultivator's ignorance of good methods of growing the crop, or to the inefficiency of the implements employed in tillage, or even to the lack of a good yielding variety of wheat. These are simple reasons which readily occur to any one and are commonly assumed to account for India's poor out-turn of wheat per acre. The real causes are, however, more subtle, and less uncomplimentary to the Indian cultivator's intelligence than the above.

A large part of the cultivators' land yields two crops within the year, and actually realizes more money than bumper *ek-fasli* crops of 20 or more maunds per acre. By long experience each cultivator knows it is not safe to put all his eggs in one basket, and almost every one prefers moderate, upstanding crops of maize and wheat to fields of bountiful promise which stand in danger of disaster by wind and flood. This is the circumstance above all others that accounts for the disparity in the out-turn of wheat obtained at the Agricultural Stations and those recorded in the Season and Crop Reports.

There are numerous other conditions tending to reduce the cultivators' out-turns which should be considered but which are never stated in comparing Agricultural Station out-turns with those recorded in revenue reports. The wheat growers for example give at least 1/15th part of their crop to the harvesters in payment of their labour and probably each alternate year some wheat is lost on the threshing floor owing to bad weather and other causes.

Then holdings are small and the cultivators are poor; at times cereals follow cereals for some years, wheat following maize or *juar* with little rest or change to the land, and with scant manuring. Or if by chance the cultivators miss their turn of irrigation, sowing may harmfully be delayed, or a plague of weeds from a careless neighbour's field or an overgrown watercourse may choke their wheat, when they are too busy, or may be too lazy to undertake weeding or to hire labour to perform the work.

Yet again and alas ! many of the cultivators are in debt, and remain merely the unwilling servants of the *baniahs*, or almost equally unfortunate, they may be year to year tenants of the lease holders of extensive tracts, when lessees and tenants alike are bent on taking the utmost from the land at the minimum cost, regardless of the maintenance of fertility and cleanliness.

In examining the agriculture of a country-side in India, it is disappointing to find a large proportion of the crops adversely affected by one or more of the unfortunate conditions mentioned, and perusal of the Season and Crop Reports is very disappointing to the enquirer who is unacquainted with Indian agricultural conditions and practice.

It is perplexing to read that ten maunds per acre is the average out-turn on 1,000,000 acres of irrigated land, while in Agricultural Station Reports out-turns exceeding 30 maunds per acre are sometimes reported. Despite what has been stated in explanation of the cultivators' failure to produce good out-turns, and even admitting that Agricultural Station out-turns are sometimes estimated on quite small plots, the great disparity existing in the field and station yields is not yet clearly accounted for.

The enquiry may be pursued by comparing the treatment which produced 25 maunds per acre on an area of 60 acres at Tarnab, with the cultivation usually given to wheat in the vicinity.

Rotation and Tillage. The wheat at Tarnab was an *ek-fasli* crop, wheat following wheat on the greater part of the area. On the cultivators' land on the other hand, wheat is almost entirely a *do-fasli* crop, following maize, and the out-turns may therefore be about one-third less than the Tarnab *ek-fasli* yield of 25 maunds per acre. This practically means that the cultivators should harvest 16 maunds per acre from their *do-fasli* land and if the cultivators' out-turn is allowed to be 16 maunds per acre, there yet remains a deficiency to be accounted for to bring the cultivators' out-turn up to the Tarnab yield.

As wheat followed wheat at Tarnab, the land was turned over by the Rajah plough before 15th June. The cultivator's *do-fasli* land, on the other hand, could not be ploughed until 15th October, after maize was harvested. *Do-fasli* wheat is sown, in fact, within a few days only of the first ploughing of the land, and the cultivator's prospects of a good yield are here far poorer than at the Agricultural Station. But the cultivator's land probably produced a crop of maize, value Rs. 60 to Rs. 70, whilst the Tarnab wheat land was fallow and renewing fertility between July and October.

Irrigation. Tarnab has no advantage in this most important aid to wheat production, both the cultivator's wheat and the station crop being irrigated once or twice only.

Inter-cultivation. Again, Tarnab has no advantage, harrowing being impracticable on irrigated land, and hand-hoeing being too expensive and slow to undertake on 60 acres of wheat.

Weeding. The cultivators may lose somewhat in this direction, as they weed less thoroughly than at the station.

Protection. There are few cultivators' fields that are not damaged by browsing animals. At Tarnab no loss occurs in this direction.

Harvesting. The cultivators give 1/15th or more of their crop to the harvesters in payment of their labour. The station paid cash, and the final out-turn was therefore not reduced in weight by the harvesters.

Threshing. A steam thresher treated the Tarnab wheat a few days after it was cut, and loss of grain did not occur on the threshing floor. The cultivators, on the other hand, are very fortunate if they do not lose 1/20th of their crop during threshing.

Variety of wheat. Under equal conditions, Pusa No. 4 may be depended on to yield one maund per acre more than the local wheat.

Now the disparity in out-turn between the cultivator's yield and the station out-turn is nearly accounted for.

It has been shown that the cultivators lost weight of wheat approximately as follows :—

	Mds.	Seers.
(1) By practising *do-fasli* cultivation	8	0
(2) By neglect of weeding	0	20
(3) By the ravages of browsing animals	0	20
(4) By paying harvesters in wheat	1	0
(5) By bad weather during threshing	0	20
(6) By the inferiority of their variety of wheat .	1	0
Add	11	20
The cultivators' actual out-turn	12	
	23	20

If to the above are added the small shares paid to the blacksmith, the carpenter, the barber, the chaukidar, and the 1/10th part so faithfully given by many to the poor in the name of God, it will be found that under reasonably comparable conditions, the out-turns actually produced on irrigated land are not as pitiable as they are usually assumed to be. The losses stated at (1) to (6) are chiefly due to circumstances over which the cultivators have little control; on no account is loss caused by mere ignorance of good practice in the simple art of growing wheat and, above all, it should not be forgotten that the profits realized by the cultivators are no less than those obtained from the heavy *ek-fasli* station crops, and it is probably true that over a period of five years or longer, the balance of profit would be in favour of the cultivators and well designed *do-fasli* practice.

By pursuing clean, careful cultivation and growing an upstanding superior variety of wheat, the cultivators can improve their out-turns, but they will not be encouraged to do so by belittling their actual attainments and placing before them high agricultural station out-turns without due regard to the difficulties that prohibit them from attaining these yields.

THE INFLUENCE OF THE WEATHER ON THE YIELD OF WHEAT.

BY

ALBERT HOWARD, C.I.E., M.A.,

Imperial Economic Botanist, Pusa.

1. INTRODUCTION.

THAT a general connection exists between the weather and the yield of crops is well known. This is referred to every year when the annual accounts of the Indian Empire come up for discussion. On these occasions, the Finance Member of Council often says that the Budget is little more than a gamble in rain. Sometimes, however, the matter is gone into in greater detail and attempts are made to treat the subject from the statistical standpoint and to apply mathematics thereto. The results obtained can hardly be said to be convincing. Apart from the scepticism with which many people regard attempts to prove a case by means of numbers, a little consideration shows that the subject is one to which, in the present state of knowledge, a mathematical treatment can hardly with confidence be applied.

The various meteorological factors like rainfall which are included in the weather are definite things and can be measured with reasonable accuracy both as regards amount and distribution. A wheat crop, on the other hand, cannot be treated in quite the same way. It is an assemblage of living machines which, by means of their chlorophyll corpuscles, are able to utilize the energy of sunlight in building up complex food substances from simpler materials, such as mineral salts, water and carbon dioxide. There is also an orderly development from the seedling stage to the mature crop and, during the whole growth period, the plants are competing with each other and are reacting to the various growth conditions—moisture, temperature, the supply of oxygen and mineral food materials in the soil, and the degree of moisture and movement in the atmosphere. Not only does the crop react to its surroundings but also the extent of this reaction depends on the stage of development reached. In addition, the various growth factors influence each other to a marked degree. For example, the rainfall not only affects the crop directly but also indirectly by altering the temperature of the air and of the soil, the atmospheric humidity and often the gaseous interchange between the soil and the air. Before we can even apply statistical methods to the connection between yield and a single weather factor such as rainfall, it is clear we must have some means of weighting the figures with reasonable accuracy. The effect of rainfall will vary with its amount, with its distribution, with the stage of development of the crop and with the character of the preceding monsoon. It will also influence, according to circumstances, the other growth factors such as temperature, soil aeration, humidity and air movement. As no two seasons in India are ever alike, it is obvious that we are dealing with too many mutually interacting variables to be able to define in mathematical terms the effect of any particular fall of rain. When we are dealing with the general effect of the weather as a whole on yield, the difficulties naturally increase with the increase in the number of factors. The most important matter connected with a wheat crop is naturally the yield of grain. This is the resultant of all the conditions of growth of which the weather is only one. It is clearly the merest speculation to attempt to deal statistically with the effect of any one factor on the system as a whole and it would appear that the subject from its nature is one to which mathematical treatment cannot possibly be applied.

There is, however, an alternative method of dealing with such questions. The growing of a wheat crop is after all a matter of applied physiology. The choice of soil, the preliminary cultivation and the supply of air and water to the soil can best be looked upon as improvements in the conditions of growth, all of which are greatly modified by the weather.

During the last eleven years, the writer has obtained a considerable amount of practical experience in the cultivation of wheat and of the effect of the various conditions of growth, including the weather, on the yield. In addition to the rainfall, the soil temperature appears to be a most important factor while the aeration of the soil seems to affect the plant more than anything else. The results of numerous observations on these questions are dealt with in the present paper.

2. THE CONDITIONS OF GROWTH OF A WHEAT CROP.

The soil conditions under which wheat thrives best have been known to agriculturists since remote antiquity and are referred to in the writings of such Roman authors as Cato and Varro. Modern investigations have naturally added to the knowledge possessed by the ancients but the cardinal importance of thorough cultivation for wheat and a soil of the proper texture and content of organic matter have been known and acted upon since the dawn of history. Provided the soil admits of copious root development and is fairly retentive of moisture, the amount of rainfall or irrigation water necessary for wheat is not considerable. A fair crop can be ripened with remarkably little moisture. Good soil aeration, by means of which the soil organisms and the roots of the wheat plant can obtain abundant oxygen and, at the same time, get rid of the carbon dioxide produced in the soil is quite as important as the water supply. Particularly is this the case during the ripening period when any interference with the aeration of the soil prevents maturation and also tends to induce rust attacks. The temperature of the soil is another important growth factor. Wheat, as is well known, is a crop of the temperate regions and is not cultivated in the hottest areas of the globe. In semi-tropical countries like India, it is only grown in the cold season and experience proves that the sowing time of wheat is largely regulated by the soil temperature.

3. THE INFLUENCE OF RAINFALL AND TEMPERATURE ON GROWTH.

Rainfall. The climatic factors which have the greatest effect on the yield of wheat in India are unquestionably the amount and distribution of the rainfall. Within limits, the distribution of the rain is more important than its amount. Provided the subsoil is fairly moist, late September and early October rains are the most significant as they not only supply moisture for the final preparations and for germination but also cool the seed-bed sufficiently for the young crop to thrive. On the other hand, a heavy monsoon ending in late August or early September which is not followed by the sowing rains is generally unfavourable for wheat in alluvial tracts like Bihar and Oudh, and in black soil areas like Bundelkhand and the Central Provinces. In the former case in such seasons, the soil is almost certain to be on the warm side at sowing time, while in the latter there may be insufficient surface moisture for germination.

After sowing is completed, the first rains, known as the Christmas rains, generally fall towards the end of December or during January. These are, on the whole, light and well-distributed and, as is well known, originate from depressions which pass over India from the direction of Persia and Mesopotamia. It is rare for rain to fall during November and early December. The Christmas rains are exceedingly beneficial to the wheat crop. They not only moisten the soil but check any tendency for the ground to get too warm. Generally speaking, they serve definitely to establish the cold weather which is so important for the well-being of *rabi* crops. These winter rains, however, are often delayed and may not appear till late in February or even in March when their influence on the yield of the wheat crop is small and may even be distinctly harmful, particularly when heavy falls occur after the wheat is in ear. Except in the extreme North-West, such rain is too late to exercise its full effect on the growth while the formation of surface crusts interferes with the aeration of the soil and tends to help in producing those conditions which bring on rust attacks. Rain and moist weather when the crop is ripe easily set up sprouting in the ear as the temperature is usually high at this period. Showers during the threshing period cause a little damage from a similar cause, but the people are very clever in protecting their grain heaps and it is rare to find that the moisture penetrates more than an inch or two. In estimating the effect of the rainfall on a wheat crop the distribution rather than the total amount is important. Late September and early October falls are the most valuable of all while early, well-distributed Christmas rains, not exceeding two inches in amount, follow next in order. Late rains, if heavy and long-continued, are decidedly harmful by preventing maturation and by producing rust. A heavy monsoon ceasing early leaves the soil and subsoil too hot for wheat in the warmer wheat tracts of the country.

Temperature. After the distribution of the rainfall, the soil temperature is perhaps the next most important meteorological factor in the growth of Indian wheat. If sown too early before the soil and subsoil have cooled down sufficiently, the wheat seedlings wither and are eaten up by white ants (Termites).[1] When sown at the proper time, however, when the soil and subsoil have cooled sufficiently, the seedlings thrive and white ants do not trouble the crop. Experience shows that the dying off of the young crop is particularly widespread in Bihar and Oudh in years when the total monsoon rainfall is large, when the rains cease early and when the sowing rains (*hathia*) fail. In such seasons, the soil is charged with large quantities of warm water and cooling is slow on account of the mass of water involved and the necessity of keeping the soil closed down to prevent too much evaporation. Such soil conditions occurred in Bihar in 1914 and again in 1915, and whenever they do it is interesting to note that the *ryots* always sow too early and often lose their wheat entirely particularly on the heavier lands which hold the most moisture and presumably cool down more slowly than the drier, higher-lying fields. The remedy for this trouble in such seasons in North Bihar is to postpone sowing till the end of October and to cool the soil by evaporation by allowing the furrows to remain open to the sun and air for two or three days according to the amount of moisture present. When this is done, there is much less trouble on account of a hot seed-bed and white ants do little or no damage.

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[1] It is an interesting fact that in such cases the wheat always germinates well and for a few days shows great promise. This is probably due to the temporary cooling of the surface soil by the evaporation of moisture during the final preparation for sowing. As soon, however, as the roots reach the warmer subsoil, decay sets in and the seedlings begin to wither. At this stage, they offer attractions to white ants which seem to be the consequence rather than the cause of the damage to wheat at this period.

So far, little has been done in tracing the connection between the temperature of the soil in the plains at sowing time and the distribution of the rainfall. The subject is being investigated in the Botanical Section at Pusa and the results will be published in due course. It is fortunate, however, that one series of Bihar soil temperatures is on record which bear on this point. These were taken by Mr. H. M. Leake at Pemberandah during the period March 10th 1903, to March 3rd 1904, and are published in detail in the account of the research work on indigo carried out at Dalsing Serai during 1903 and 1904 by Messrs. Bloxam and Leake. These observations were made thrice daily at 8 A.M., 1 or 2 P.M. and at sunset. The spot selected was the middle of an exposed area of high, light land which was kept free from weeds. The weekly average temperatures at a depth of four inches at mid-day (1 to 2 P.M.) are given in the following table in which the rainfall is also recorded :—

TABLE I.

Soil temperatures and rainfall at Pemberandah.

Period	Average temp. (4″ deep at 1 or 2 P.M., in degrees Centigrade)	Rainfall (in inches)
Sep. 2—8	30·4	1·4
9—15	30·5	1·0
16—22	30·4	0·1
23—29	29·7	0·6
30—Oct. 6	29·1	2·6 Including 1·6 inches on Oct. 6th.
Oct 7—13	28·0	0·8
14—20	28·0	
21—27	24·9	
28—Nov. 3	22·9	
Nov. 4—10	21·3	
11—17	19·8	
18—24	20·0	
25—Dec. 1	18·7	
Dec. 2—8	16·5	
9—15	15·8	
16—22	14·4	
23—29	15·2	
30—31	13·1	

It will be observed that there is a rapid fall in the weekly averages after October 20th and that during the succeeding fortnight the temperature fell more than five degrees. The daily temperatures (at a depth of 4 inches and at 1 or 2 P.M.) during this period are given in Table II.

TABLE II.

Daily temperature readings at Pemberandah after the sowing rains.

Date		Temperature (Centigrade)	
Oct.	16	29·5	All readings taken at 4" at 1 to 2 P.M.
	17	28·7	
	18	28	
	19	26	
	20	26	
	21	26	
	22	26	
	23	25	
	24	24·7	
	25	24·5	
	26	24·5	
	27	24	
	28	23·5	
	29	23	
	30	23	
	31	22	
Nov.	1	..	
	2	23·5	
	3	22·5	

The fall in temperature from the middle to the end of October is fairly continuous and amounts to 7°·5 C.

Wheat sown in such a season on October 16th would probably have died out while sowings made during the last week of the month would have developed rapidly without a check. In such years when the *hathia* is received, there is often a marked change in the character of the weather about October 20th, the air feels fresher and westerly breezes set in. When these have been blowing for a week or so and the cold season appears to be well established, wheat can be sown without risk. The subject, however, needs more detailed study and the wind velocity, wind direction as well as the humidity of the air should be recorded. The temperature observations on low-lying fields containing much moisture should also be compared with those simultaneously obtained on high-lying, lighter and drier land. These meteorological observations should then be correlated with the extent of root-development and with the general above-ground growth of the wheat crop. It is certain that, when the seed-bed remains on the warm side, the root-development is poor and the plants begin to shoot prematurely. This tendency is perhaps even more pronounced in the case of *sarson* (*Brassica campestris*) and yellow flowered tobacco (*Nicotiana rustica*) than in the case of wheat. Either of these two crops could be used as living thermometers whose indications would supplement those of the ordinary instrument.

4. Some Practical Applications.

There are at least two directions in which the ideas in this paper can be made use of for practical ends. One relates to the duty of irrigation water in the warmer wheat tracts of India and the other to the improvement of crop forecasts.

Irrigation. The provision of moisture for crops is considered to be the object of all schemes of irrigation. It is more than probable, however, that artificial watering serves another purpose in the case of *rabi* crops, namely, the cooling of the soil to enable vigorous root-development to take place. This being so, the possibilities of the extended use of irrigation water in tracts like South Bihar, the Central Provinces and Bundelkhand ought to be re-considered. It might pay to construct tanks (reservoirs) in these areas solely for the purpose of watering land once in October prior to sowing. This irrigation would cool the land, would give plenty of moisture for germination which, under judicious management, would carry the crop through to harvest. In the case of well irrigation in certain parts of Oudh, there appears to be, on the stiffer soils, an opening for wheat growing with a single watering applied in November followed by the sowing of a rapidly maturing wheat like Pusa 4.

Crop Forecasts. Although the methods adopted in the preparation of crop forecasts in India are a great advance on those previously in use, nevertheless the application of physiological ideas would lead to a still higher degree of accuracy. In framing the first wheat forecast, the distribution of rainfall after the middle of September, the mean air temperature during October and the direction of the wind in the Gangetic plain should receive particular attention. The root-development and the foundation, as it were, of the crop depend on these factors. In the second forecast, the distribution of the winter rains and the general air temperatures during December and January are significant. Light, well-distributed rainfall, low temperatures and clear, bright weather during the vegetative period are the factors on which the future yield depends. Long spells of abnormal hot weather during this phase or very heavy rains are sure to be harmful. In the final forecast, two things are important—the rainfall and temperature during the ripening period and the manner in which the ears ripen. Anything more than the lightest rainfall during the period of maturation is harmful and temperatures above the average are inimical to a high yield. The appearance of the ears from the time the grain is half ripe till the harvest is perhaps more important than any other indication in estimating the final yield. For a full crop there is a characteristic development in the shape of the spikelets and in the colour of the straw and ears which cannot be mistaken. When half ripe, the spikelets bulge considerably due to the swelling of the middle grain and the ear assumes an uneven, turgid condition. The straw and chaff have a bright healthy appearance which is continued till the crop is ripe. The contrast between this condition and the look of a low-yielding crop is very marked. In the latter case, the ears remain narrow, the spikelets are regular, the ears and straw appear lifeless and the full colour of the chaff is not developed. The range between these two conditions is, of course, great and amounts to at least five maunds an acre. In the United Provinces in 1915, when the conditions for ripening were exceedingly unfavourable and the forecasts of outturn proved to be optimistic, the yield would have been reduced by five maunds to the acre had the appearance of the ripening ears been taken into account. The 1916 crops in parts of Bihar, on the other hand, should have been increased an equal amount. A ripening factor, which can best be judged by the officers of the Agricultural Department and which need only be determined in each of the chief wheat-growing tracts of a Province would be most useful in correcting the ordinary estimates of area and yield sent in by the Revenue authorities.

SUGARCANE CULTIVATION IN NON-TROPICAL PARTS OF INDIA.

BY

WYNNE SAYER, B.A.,

Assistant to the Agricultural Adviser to the Government of India.

We are led to write this article in response to the following criticism published in *Commerce* of Calcutta, dated 4th May, 1916 :—

"The wonderful progress made in sugar-beet cultivation in Europe and cane cultivation in Hawaii, Mauritius, Java, Cuba, and Louisiana, show what science, higher education, and common sense can do for an industry. We in India are still waiting for the Agricultural Department to show us if any possible advantage can be derived from the experimental work carried on by the officials in their effort to solve what seems to be an almost hopeless task. The possibility of improving sugarcane cultivation in Bombay, the Central Provinces, Bengal, Assam, and South India we realize : but what the Agricultural Department expects to do for cane in Bihar, the United Provinces, and the Punjab is beyond our comprehension. We are led to these reflections because we recognize the scope for improving cane grown within the sugar belt and we therefore see no necessity for the department to waste their energy on this cultivation in the United Provinces and the Punjab, where cane cannot be grown satisfactorily owing to adverse climatic and soil conditions. That the climate in the United Provinces and the Punjab is not suitable to sugarcane is a recognized fact; and consequently, we cannot include these in the sugar belt of India. Parts of Bengal, Assam, the Central Provinces, Bombay, and Madras are within the sugar belt we know ; that the soil and climate in Bihar is not suitable for cane we also know. Why does the Agricultural Department then employ time and labour on research work for securing cold-resisting canes with early maturing tendencies, when there is an ample scope for expansion and improvement in provinces within the sugar belt? Although plants can to a certain extent adapt themselves and be domesticated outside their climatic belt the fact remains that their cultivation, never really becomes a commercial success, but will always remain an uncertain proposition. With sugarcane this has been borne out time and again and for additional proof we need only compare the yield obtained in the provinces of India such as Bombay, the Central Provinces, and Bengal against Bihar and the United Provinces. In Queensland the cane is grown with uncertain prospects as far south as Nambour, 60 miles north of Brisbane. Cane is grown to a small extent in New South Wales but not successfully. In the Southern States of the United States of America cane has been and still is grown on a small scale as far north as Georgia, Mississippi and Texas. In the last State they even tried to grow cane in the 'Pan Handle' of Texas; but these attempts have not been successful and yet people persist in its cultivation. We could quote a number of other, countries where certain climatic and soil conditions have created crop belts, all attempts to improve the types of so-called domesticated crops having failed. These matters could possibly be settled with adequate research work, but it takes a high order of ability and time and money to accomplish anything in this direction, and when the work is completed by the department private resources to carry the scheme further on industrial lines will be necessary. In order that India should become independent of Java sugar the sooner the Agricultural Department turns its attention to the expansion and improvement of cane cultivation in areas within the sugar belt, the greater the possibilities for India to arrive at the necessary state of independence from foreign imports."

On this the *International Sugar Journal*, June 1916, writes as under:—

"*Indian Sugarcane Cultivation.* A Calcutta contemporary, *Commerce*, takes occasion to criticize the Department of Agriculture of India for its policy in devoting its energy to experimental cane work in those provinces of India which it declares are outside the sugar belt and therefore are quite unsuitable for sugarcane cultivation. These provinces are Bihar, the United Provinces, and the Punjab, and it seems to be concluded in competent circles in India that in them cane cannot be grown satisfactorily owing to adverse climatic and soil conditions. It is therefore asked why the Agricultural Department should employ time and labour on research work for securing cold-resisting canes with early maturing tendencies, when there is ample scope for expansion and improvement in provinces within the sugar belt, such as in Bombay, the Central Provinces, Bengal, Assam, and South India? Our contemporary in fact states that they in India are still waiting for the Agricultural Department to show them if any possible advantage can be derived from such a hopeless policy; and it strengthens its criticism by pointing out that, although plants can to a certain extent adapt themselves and be domesticated outside their climatic belt, the fact remains that their cultivation there never really becomes a commercial success, but will always remain an uncertain proposition. It is possible that the authorities will reply that they have introduced the experiments where they have found that the native population was accustomed to cane cultivation and will take more or less kindly to schemes of amelioration. But it is a fundamental necessity that the soil and climate should be suited to the plant, and if, as *Commerce* claims, the soil and climate of the cited provinces are not suitable, then it does indeed seem a pity to waste time and money on experiments which will certainly not produce any commercial success or assist materially in making India more independent of the supplies of Java sugar. Better concentrate attention and energy on lands within the recognized sugar belt. But we should like to have the official explanation of the policy thus criticized."

On reading these, the first idea that strikes us is that the writer of the article in *Commerce* has completely lost sight of the main point in connection with the Indian sugar industry that the problem in India is a dual one. The word sugar does not solely refer to the refined article which is an obsession firmly fixed in the minds of so many. There are two methods of utilizing the sugarcane when crushed, namely, *A* the production of *gur* for eating and *B* the production of refined sugar either (i) direct from the cane, or (ii) from *gur*. India's production of sugar (mostly raw sugar) excluding that in Native States is close on 3 million tons of which about 16,000 tons only are exported, the rest is all consumed in the country. Over and above this she has to import over 800,000 tons of refined sugar mostly from Java and Mauritius to meet the continually expanding demand for this kind of sugar. She is therefore far and away the greatest producer and consumer of sugar (raw) in the world, and I would ask what country can possibly supply her with such an enormous quantity. Now the points to be borne in mind are (1) that the vast majority of the Indian population prefer *gur* which is as nutritious as sugar, or rather more so, and (2) that *gur* also enters into many Indian food preparations and there is no likelihood of the demand for *gur* falling off in the near future. On the contrary, the increase in wages and the rise in the price of agricultural produce have enabled certain classes of the labouring and agricultural population to increase their consumption of this commodity. Again, as none of the other sugar-producing countries produce *gur* it must be manufactured within the country itself, for it would not pay to produce it abroad. These being the peculiar conditions we can now proceed to examine how far the tropical parts of India, which are more suited to cane growing, can meet this huge demand. If we refer to the total area under cane in India, we find that about 90 per cent. of the acreage is in Northern and North-Eastern India, *i.e.*, United Provinces, Punjab, Bihar, Bengal, and Assam. Not more than 10 per cent. is in Peninsular India or what may be called the *sugar belt*. It will thus at once be seen that Bombay, Madras, and the Central Provinces cannot possibly supply the total quantity of *gur* required by India. Doubtless it may be asked why not, if there is a market and the land is suitable for cane ? But there are these restrictions. Extension of cane cultivation in these parts is limited by the supply of water, the competition of paddy and such other food crops, and, what is so frequently lost sight of in improving and increasing areas under a particular crop, the economic balance which must be kept level; for unless the price of food is to rise in the district, the ratio between food and money crops must be kept in that state of balance, which will keep food at its lowest and yet allow the district to grow the greatest amount of money crops available, and it will generally be found that the district has calculated this to a nicety. Canal irrigation is very limited in Peninsular India and irrigation from wells has to be resorted to. This is an uncertain and costly method, and so there is no great extension of area to be looked for in these parts save where new canals are opened. This fact has led districts out of the sugar belt to grow their own cane, for the limiting of the area in the sugar belt would have the effect of forcing up the price of sugar if the demand was great from all other parts of India.

Another reason for their cultivation out of the belt is that cane as a commercial crop is more paying than rice, wheat, or cotton, always provided the necessary labour and water are available and that the cultivator and his family do most of the labour. The following average values of crops in India will make this point clear.

Jute	Rs. 145 per acre.
Sugarcane	Rs. 127 per acre.
Rice	Rs. 52 per acre.
Wheat	Rs. 36 per acre.
Cotton	Rs. 32 per acre.

It will be argued that sugarcane occupies the land for over a year while the other crops occupy at most six months. To this the reply is that in India cultivation of any crop is taken up after the ryot has considered how much labour and cattle power he has at hand and which he must keep employed throughout the year. The ryot looks to his own immediate necessities first. He therefore plants a variety of crops to safeguard himself against ruin resulting from the failure of rains and sugarcane naturally comes high on the list which is the result of a long chain of circumstances proved and tested by years of experience. India is not a country of capitalist farmers with large landed estates. She is a poor country of which the backbone is the illiterate peasantry. The holdings are uneconomic, being small and scattered. Leaving aside the question of expropriation which is unthinkable we have to make the most of the existing situation.

In Bengal, as shown above, jute is more paying. The date-sugar industry in this province is capable of improvement. Some increase in the area under sugarcane is also possible, but the following proverb current in Eastern Bengal will indicate the ryot's ideas about this crop. "Unless a man has seven sons and twelve grandsons he should not cultivate sugarcane." We do not therefore think there is any prospect of a large extension of area under sugarcane in Bengal. It is true that in Assam there are possibilities for developmen tespecially in Goalpara and Kamrup and Nowgong, but labour in Assam is notoriously deficient and the climate of the country in the rains is not calculated to stimulate the inhabitants to any prolonged physical exertion. Further the waste land suitable for cane cultivation has to be reclaimed, new roads made, and in some places either labour has to be imported or labour-saving machinery, such as steam ploughing tackle, has to be introduced. All this spells capital and it is only large capitalistic concerns that can do all this. Nothing in the way of extension can be hoped for from the comparatively limited areas under cane under the ordinary ryot's conditions and to hypothecate on such a capitalistic basis when dealing with the ryot is to bring your scheme under ridicule. A man who farms on the turn of a rupee can't discern the ultimate money saved by using steam tackle.

Turning to Bihar we can confidently say that if there is any part in India where the development of white sugar manufacture is most promising it is here. Even before the outbreak of war the central factories working in Bihar were a financial success. In some parts of Bihar cane is grown without irrigation. It is true that the out-turn per acre of cane is not high but as the cultivation charges are in the same ratio the crop is a paying one. The *gur* produced in Bihar is of inferior quality suitable only for refining purposes and hence the cultivators are not averse to selling their cane direct to factories. In the opinion of many competent authorities practically the whole of North Bihar is suitable for the growth of cane.

The heavy crops of cane on the Pusa farm where the soil is by no means of the most favourable type in Bihar for the growth of cane but rather the reverse show what can be done by improved cultural methods. The late Agricultural Adviser to the Government of India was of opinion that by the introduction of an improved cane and improved methods of cultivation in Bihar the production of sugar per acre could be raised to a very much higher figure than it is now, and it is not too much to say that it could be easily doubled. And yet the writer of the article in *Commerce* says the soil is unsuitable in Bihar. We wonder where it is possible to find better, more fertile, and more easily cultivated soil than in Indo-Gangetic alluvium. Its fertility is probably largely due to its water-holding capacity. A crop can exist in it through the hot weather when it would fail in most soils. It is true that the advent of severe cold in November affects the growth of cane and also that the crop is not so heavy as in Java, but this is not so great an evil as to put sugarcane clean out of court. We admit that in Northern India thin reed-like canes are grown. Though the sucrose-content is not very low they have a high proportion of fibre and consequently yield less juice to the mill in single crushing. In other sugar-producing countries thick canes are the rule, giving from 30—40 tons per acre under liberal manurial and cultural treatment. Here the crop does not receive that same amount of attention, and as regards manuring it may almost be said that this nitrogen-loving crop practically goes without it in Northern India. It should, however, be remembered that in Northern India excluding Punjab the average out-turn per acre is never below 15 tons of cane, and the cost of cultivation, etc., does not exceed Rs. 70 as the ryot supplies his own labour and cattle power. The crop is therefore a paying one for him. In favoured localities in Northern India people grow *pounda* canes and they are more profitable, but as a rule they require greater care in cultivation, liberal manuring, and are more liable to disease and also to attacks from jackals, etc., and hence the cultivator who has probably experienced all these set-backs plants thin canes and plays for safety.

Coming specially to the United Provinces which have about 1,300,000 acres under cane it is necessary to emphasize what Mr. Moreland has already pointed out that this crop ensures regular employment to a large number of labourers at a time when other work is hard to find, and given a good season it enables the cultivator to pay his rent and put something by, or give his family and friends a treat. Further it is the stand-by of the hard-working man, calling for just as much labour as he can put into it, and there is perhaps no other crop which rewards skill and labour to the same degree. Any decline in the cultivation of this crop which usually occupies the superior land should therefore result in the lowering of the standard of agriculture in these provinces; on the contrary, a reasonable extension is eminently desirable in the general interest of the community. After a succession of good years the cane area increases by as much as a quarter of a million acres, and after bad seasons it falls back as much as half a million acres. The area under cane appears to be governed by probable prices and by the economic position of the cultivating classes for the time being, *i.e.*, possession or lack of necessary capital. In short, it acts as a financial barometer of considerable accuracy and delicacy.

It will thus be seen that this crop is of vital importance to the United Provinces. Bengal has its jute as a paying crop, Bihar its indigo or tobacco, but the United Provinces have nothing between cane and far less remunerative crops. It is therefore not a question of a few central factories or a small class of consumers, but affects the welfare of a very large part of the rural population. And as at the outside only ⅕th of the total production of the United Provinces is converted into sugar it cannot be said that the cultivators are losing over this crop. In fact those parts of the United Provinces like the Meerut Division which export *gur* show an increase in cane cultivation. It is only parts like Rohilkhand which used to export a large quantity of country refined sugar that have felt the competition of the foreign product and shown a decrease in the area under cane. It may be argued that this extensive cultivation of cane in the United Provinces is due to irrigation facilities. We admit that facilities for cheap irrigation have been greater in the United Provinces than in other parts, but so long as no equally paying crop can be substituted the ryots are wise in cultivating cane and the Agricultural Department equally so in trying to ascertain whether it can help the ryots in increasing their yield of stripped cane per acre or in improving their methods of *gur* manufacture. In fact, while the cultivators hardly get more than 15 tons of cane per acre, on Experiment Stations 22 to 25 tons of sugarcane of a purity of 85 have been obtained. This variation in out-turns indicates vast possibilities of improvement. Already Mr. Clarke has got a type of cane J. 33 which is far better than any *desi* variety at present grown by the ryots. Not only is there no question of the crop being given up in the United Provinces, but there is a possibility of extended area coming under cane as the result of gradual extinction of poppy cultivation.

The Punjab has nearly 15 per cent. of the total area under cane in India. With the increasing popularity of wheat and cotton in this province, there is no substantial increase in the area under cane, taking the province as a whole. While there is a slight tendency to decrease of area in the older districts some expansion has taken place in the new canal colonies, and if it were not for the scarcity of labour and of manure the increase would probably have been greater. It is true that the climate of Punjab is a very severe one in winter and tests the hardihood and vitality of plants to the utmost, and it is especially trying to sugarcane; still in districts with a fairly plentiful and secure supply of water in some form or other its cultivation is relatively important. The question may naturally be asked why this should be so? We have already explained the general conditions which induce the ryots to take up the cultivation of this crop. The province is not able to meet its own demand of *gur* fully, and as it is far removed from the sea-coast foreign sugar has to stand heavy freight charges which acts as some sort of protection. Though the out-turns are low the cultivators will not give up the crop so long as it is paying to them. The ryot is not a capitalist or a specialist with a large capital on hand anxious to increase his profits every year. He is satisfied if a crop provides labour for himself or his family all the year round and leaves some net profit.

We think we have written enough to show that in the rural economy of Northern India this crop plays a very important part, and hence the Agricultural Department is bound to study the crop with a view to suggesting improvements. As Dr. Barber, the Government Sugarcane Expert, has pointed out we want better, richer canes with larger out-turn in the field, greater resistance to disease, and yet adaptable to the methods of cultivation adopted by the cultivator. Improvement in the last particular will only be likely to come if the variety of cane provided is more responsive to intensive cultivation. Although one or other of the thick tropical canes have been a success on almost every Government farm where they have been tried there is no doubt that as a whole tropical canes are not suited either to the northern tract or the ryot's method of cultivation in vogue there. The tropical thick canes needing good cultivation and heavy manuring are often useless to him for simple lack of the means to grow them properly. What is needed is a hardier type of cane capable of holding its own with the canes grown under field conditions in Northern India. Such types are not usually available among the canes grown in tropical countries, and the only way to get them is to produce them ourselves. No particular variety will suit all parts of the vast area of the Indo-Gangetic plain. A series of seedlings must therefore be evolved, each one specially fitted for the particular region where it is intended to replace the local kind. There seems only one way in which this can be attempted. In each case the best local kind accustomed for centuries to its peculiarities of climate and treatment should be selected out and crossed with the richer southern varieties so as to combine its resistant properties with the imported richness and bulk. The work is thus complicated in that a series of separate problems have to be solved and a separate series of seedlings evolved for each geographical region.

To conclude: It is clear from the above that so long as India requires *gur* in large quantities and refined sugar only in comparatively smaller ones we are not justified in saying that the crop has no right to exist in non-tropical parts. It is only these parts that are able to supply the enormous demand for this commodity, and as cane cultivation is profitable to the ryots in these districts as it stands, it is the legitimate function of the Departments of

Agriculture to institute experiments with a view to find out whether any better varieties can be substituted, or whether any improvements in the cultivator's methods of cultivation and *gur* manufacture are possible, and this opens a wide field for study. While the question of *gur* is receiving attention the problem of white sugar manufacture is not being lost sight of. In the Gorakhpur Division of the United Provinces and in Bihar where sugarcane cultivation is concentrated new central factories are springing up. We do not think it necessary to go over the beaten ground and say what experiments have already been made and what improvements effected in this industry in India. It will suffice if we refer the readers to the article on "Indian Sugar Industry", published in the *Agricultural Journal of India*, January 1916, which gives a useful summary of the present position.

To sum up the case in a nut-shell it is this. Cane is grown outside the sugar belt for very good reasons—reasons which have stood the test of years and so are entitled to every respect, and while a crop continues to pay (for there are precious few unpaying items on the ryots' programme) occupies a considerable acreage and supplies a demand, it is not possible to pass it by. It forms a radical part of the district economy, and unless you have another crop equally useful and paying to replace it by, it behoves you to do your best to improve the existing state of things. To fold your hands and say *kuchh parwah nahin* the crop is outside its proper "area," and to split hairs of that kind is to prove the Department completely out of sympathy with the ryots' present wants. No; until it is possible, and I do not think it will ever be so, to replace the cane crop by an effective substitute and to supply the demand for *gur* from other parts—two jobs which will not be done in this century, if ever, it is up to the Agricultural Departments to endeavour to improve the present cane crop. A definite result accomplished now will repay itself a thousand times over in the confidence which it inspires in the ryots for the future. The proverb of "the horse that starved while the grass was growing" is all too true. The ryot wants help now and help that will improve his present state, and a long list of theories may do on paper but are pretty useless for immediate practice. We shall welcome *Commerce's* reply and our columns are open to it.

THE CLASSIFICATION OF INDIGENOUS INDIAN CANES.

BY

C. A. BARBER, Sc.D. (Cantab.),

Government Sugarcane Expert, Madras.

DURING the past two years it has been found impossible to proceed with the classification of Indian canes, commenced in the Memoir[1] describing the varieties collected at the Gurdaspur Farm in the Punjab. This has been due to the urgent need for systematizing the seedling work and placing it on a definite basis. The collection of varieties has, however, proceeded during visits to various parts of India and, although the collection is far from complete, a fairly representative series has been got together. The numbers of plots in the cane-breeding station devoted to varieties at present consist of thick (*Pounda* and introduced) canes 120, thin (Indian) canes 112. At each planting season it has been attempted to place the latter plots together in groups of obvious systematic connection. This has been fairly easy with the main classes, *Mungo, Pansahi, Nargori*, and, to some extent, with *Saretha*, but, besides these, there has accumulated a large number of unclassified forms. Among the latter, it is natural that special attention has been attracted to the two large indigenous cane varieties of South India, *Cheni* and *Naanal*, for from them a number of seedlings have been obtained. During the present cropping season (1916) an attempt has been made to deal with the unclassified series and, although the work was necessarily incomplete and rather hurried, results of considerable interest have already been obtained. It has been demonstrated, namely, that these two South Indian canes have allies in almost every province, even extending to the Punjab, where their analogues may be found in the *Katha* and *Dhaulu* of Gurdaspur respectively recently described in detail.

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[1] Barber, C.A. Studies in Indian Sugarcanes, No. 1, *Memoirs, Department of Agricu in India, Botanical Series*, vol. VII, no. 1.

Naming these two series after the generally best known members, those that have been most widely distributed for trial over the agricultural stations of India, we may speak of *Saretha* and *Sunnabile* groups. Quite a number of the unclassified list have been ranged under these two heads, and full descriptions, drawings, and photographs have been taken of some of them during the recent harvest.

Among those thus dealt with in the *Saretha* group are *Baraukha Ukh* (Cawnpore), *Ganda Cheni* (Mysore), *Chin* or *Chunnee* (Aligarh, Shahjahanpur), *Hullu Kabbu* (Bellary district of Madras), *Jaganathia* (Bihar), *Khari* (Bengal), and *Saretha* (Meerut).

The *Sunnabile* group includes *Bansa* (S. Bihar), *Bansi*, probably the same as *Khadya* (Bombay), *Dhor* (Harrai and Seoni, Central Provinces), *Kaghze* (Aligarh, Pilibhit) *Ketari* (Behta, Bihar ?), *Mojorah* (Assam), *Naanal* (Trichinopoly and Tanjore), *Putli Khajee* (Assam ?), *Rakhra* (Shahjahanpur), and *Sunnabile*, probably the same as *Bansi* (Bombay).

The object of the present note is, firstly, to present a classified list of Indian canes collected in the cane-breeding station, for the use of Provincial Officers, and, secondly, to invite the addition of further varieties which we have not at present obtained. As it is proposed shortly to describe the varieties named above in a Memoir, Provincial Officers are earnestly requested to collect any information that they can regarding the synonyms, distribution, and field characters of these canes, and all such information will be duly acknowledged when describing the varieties.

The following is the preliminary classification of the varieties on the cane-breeding station, with the sources from which they have been obtained :—

(1) *Mungo* group.

Mungo, Sabour.
Paunri, Sabour.

Hemja, Bhikanpore, Sabour.
Buxaria, Sabour.
Burli, Ottur.
Kuswar, Ottur, Partabgarh, Aligarh.
Lewari, Sabour.
Poraya, Sabour.
Matna, Aligarh, Shahjahanpur.
Matna Ukh, Cawnpore.
Rheora, Sabour.
Reori, Partabgarh.
Khatuia, Aligarh.
Agoule 1, Shahjahanpur.
Katara, Barah, Partabgarh.
Ramgol, Partabgarh.
Sarauti, Partabgarh.
Pararia, Aligarh, Shahjahanpur.
Matanvar, Partabgarh.
White Pararia, Shahjahanpur.
Dark Pindaria, Shahjahanpur.
Kharwi, Shahjahanpur.
Patarki Mungo (Partabgarh), Gurdaspur
Matki Mungo, Ottur.

(2) *Saretha* group.

Katha, Gurdaspur.
Lalri, Panipet.
Kansar, Gurdaspur.
Chin, Partabgarh, Aligarh.
Chunnee, Shahjahanpur.
Mesangen, Jullundur.
Saretha, Partabgarh, Jubbulpore.
Dhaur Saretha, Aligarh.
Chynia, Barah.
Baraukha Ukh, Cawnpore.
Jaganathia, Barah.
Ganda Cheni, Mysore.
Khari, Sabour, Jubbulpore

Hullu Kabbu, Hagari (Bellary District).
Raksi, Shahjahanpur.
Burra Chunnee, Shahjahanpur.
Ramui, Shahjahanpur.

(3) *Sunnabile* group.
Dhaulu of Gurdaspur, Gurdaspur.
Teru, Gurdaspur, Harchowal.
Ekar, Jullundur.
Dhor, Jubbulpore.
Hotte Cheni, Mysore.
Rakhra, Partabgarh, Shahjahanpur.
Kaghze, Aligarh.
Sunnabile (Bombay), Jubbulpore.
Khadya, Manjri.
Bansi (Bombay), Nagpur.
Putli Khajee (Assam ?), Ottur.
Bansa, Sabour.
Ketari, Sabour.
Mojorah, Assam.
Naanal, Tanjore.

(4) *Pansahi* group.
Ketari, Sabour.
Merthi, Aligarh.
Dikchan, Partabgarh.
Sanachi (Dumraon), Gurdaspur.
Yuba (Natal), Pusa.
Chynia, Sabour.
Kahu, Gurdaspur.
Lata, Sabour.
Maneria, Sabour.
Pansahi, Sabour.
Sada Khajee (Assam ?), Ottur.
Bharanga, Shahjahanpur.

(5) *Nargori* group.
Nargori, Sabour.
Kewali. Sabour.

Baraukha, Sabour, Pursa, Shahjahanpur.
Ketari, Sabour.
Chynia, Sabour.
Sararoo, Jubbulpore.
Manga, Shahjahanpur.
Agoule 2, Shahjahanpur.
Kalari, Nagpur.
Katai, Sindewahi.
Mungo (*sic*), Shahjahanpur.
Newra, Shahjahanpur.

(6) Unclassified at present.

Bodi, Gurdaspur.
Dhaur, Aligarh, Shahjahanpur.
Dhaura of Azimgarh, Gurdaspur.
Dhaulu of Phillaur, Phillaur.
Kinar, Aligarh.
Kanara, Jullundur.
Agol (Pilibhit), Partabgarh.
Khagri, Sabour, Dacca, Rajshahi.
Ikri, Pursa.
Khelia, Sabour.
Barhai (Jubbulpore), Gurdaspur.
Barahi, Jubbulpore.
Barokha, Shahjahanpur.
Shakarchynia, Sabour.
Betakali (Dumraon), Gurdaspur.
Kalkya, Manjri.

Many of these varieties have at present been insufficiently studied, being only recently received. There are certain obvious resemblances among the unclassified canes, which may be of use in the framing of new classes or obtaining connecting links between those already instituted. Thus there is little doubt that *Ikri*, *Khelia*, and *Khagri* are closely connected, while *Bodi*, *Betakali*, and *Dhaulu* of *Phillaur* seem to be transitional stages between the *Sunnabile* and *Mungo* groups. The position of others is not yet very clearly defined.' Thus *Patarki Mungo* resembles *Bodi* and

Matki Mungo reminds of *Katha,* although both have been included in the *Mungo* group, and so on. But, in the main, the classes show true systematic connection and, in many cases, different names probably refer to the same cane growing in different parts of the country. The localities mentioned do not always indicate the true places where the canes are grown, as most of the varieties have been received from Government farms where collections have been established for the comparison of different forms. Any information which will help to fix the true vernacular names and the exact range of any variety as cultivated will be of special value.

It is to be noted that the lists given above do not include many well known Indian names. Besides obviously *Pounda* canes, such as *Pundia, Shamshara, Saharanpuri, Poovan,* etc., there are such others as *Kajla, Vendamukhi, Magh, Dahlsunder, Yerra,* about which some doubt may exist, and the line is sometimes very hard to draw. But the principle has been adopted of excluding all canes about which there is any doubt, and it is quite possible that further study may cause the introduction of some of the thicker canes into the indigenous series, as has recently been the case with *Mojorah, Sada Khajee,* and others. In other words, thickness is not the only determining character, and the present classification can in no sense be considered the last word in the matter.

CATTLE POISONING BY *JUAR* (*ANDROPOGON SORGHUM*) AND ITS PREVENTION.*

BY

C. SOMERS TAYLOR, B.A.,

Agricultural Chemist to the Government of Bihar and Orissa,

M. N. GHOSH, M.A.,

Assistant Professor of Chemistry and Physics, Sabour Agricultural College.

JUAR is a crop which is principally cultivated for fodder in Northern India, and as such the stalks are cut while green, before the ears have formed. It is usually sown in the hot weather before the rains, and in consequence if the rains do not set in early enough the conditions become unfavourable for a good growth and the plants become stunted. Very young plants as well as those which have become stunted, are dangerous to be used as a cattle food, on account of their containing a glucoside which, under certain circumstances, breaks up and yields prussic acid which is a violent poison. The poisonous properties of such *juar* have long been recognized and Watt[1] refers to a prevalent but wrong belief among the Indian cultivators that the poison is the result of an insect which infests the plants when the crop suffers from deficiency of rain. The Indian cultivator, however, could not be blamed for his wrong belief, for even among men of science the true explanation of occasional cattle poisoning by *juar* was not known before 1902, in which year, the prussic acid yielding glucoside was discovered.

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* Reprinted from the *Agricultural Journal of the Dept. of Agri., Bihar and Orissa*, vol. III, part II.

[1] *Dictionary of Economic Products*, vol. VI.

Owing to unfavourable conditions at the time of planting this year, much *juar* was stunted and many bad cases of cattle poisoning occurred in the villages round Sabour. The first part of June was specially unfavourable for the agriculturists, for the expected showers did not come off and there was a long period of hot and dry weather. The *juar* crops, specially those in high lands, suffered in consequence and there was an accumulation of the poison yielding glucoside in the plants in quantities sufficient to cause fatal effects. As many as nine bullocks died in one village alone, some having strayed into *juar* fields and some having been actually fed with the stunted crop. These deaths were not reported immediately or we should have endeavoured at once to find the quantity of the poison present in the poisoning crop at the time of the death of the animal. In fact ten days passed before we received the information, so that any attempt to estimate the quantity of prussic acid at the time of poisoning was impossible. The weight and constitution of the crop changed very rapidly indeed at that time, and we were therefore compelled merely to estimate the quantities of the poisonous principles in the plants as they stood ten days after they had been found poisonous to cattle. It is likely, however, that at the time of death the quantities existing in the crop were far greater than the amount estimated by us.

The largest quantity of prussic acid that we were able to obtain from the crop of one of the fields where as many as three deaths had taken place was about half a grain per pound of the crop. This quantity may at first sight appear to be small, but when it is considered that only four to five grains of the anhydrous acid in a single dose may be sufficient to cause the death of an ordinary country beast, it is obviously dangerously high. A country bullock will easily eat 30 seers or 60 lb. of *juar* which at the time of our analyses would have contained 30 grains of prussic acid or at least six times the fatal dose. In another field from which no cattle had been fed there was about as much prussic acid as one grain per pound of the crop. Towards the end of June and the beginning of July, there was plenty of rain, the *juar* plants rapidly grew up, and in a few weeks the quantity of prussic acid they were able to furnish, diminished so much as to be quite harmless. It may strike one as peculiar, that although a large number of goats strayed into the fields and fed upon the *juar* leaves at the same time as the bullocks were dying of poison, yet there was not a single case of mortality among them.

That *juar* is poisonous to cattle in the early stages of its growth and loses its poisonous qualities when it is nearing maturity has long been recognized. We have already said that its poisonous action is due to the presence in the plants of a cyanogenetic glucoside, *i.e.*, a glucoside capable of yielding prussic acid. Glucosides are compounds which on treatment with dilute acids or by the action of unorganised ferments break up into several substances of which glucose (a compound belonging to the sugar group) must be one. Now *Dhurrin*, which is the name given to the glucoside of *juar*, in the same way breaks up into glucose and two other substances of which prussic acid is one. An enzyme or unorganised ferment exists in the plant itself and in presence of water breaks the glucoside up with the result that prussic acid is given out. Dr. Auld [1] maintains that the glucoside itself is not poisonous and that in the animal the saliva and secretions of the stomach have a remarkable effect upon restraining the fermentation of the glucoside, so that an animal may not die, even if it has taken up enough of the pure glucoside. In the case of green *juar*, however, its juices are acid and act in the opposite direction to the saliva and stomach secretions, neutralizing their effects. In consequence it is found that, when the *juar* stalks and leaves are eaten green, fermentation of *Dhurrin* takes place in the stomach itself, and if there is enough of it, the animal dies as a result of prussic acid poisoning. It is possible that immature *juar* if fed with ground chalk would be far less dangerous, as this would neutralize the excessive acidity and prevent the formation of prussic acid.

The amount of *Dhurrin* in *juar* is not constant throughout the life of the crop and changes considerably according to the age of the plants. Climate, weather, and perhaps soil conditions are probably important factors which also determine the change.

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[1] *Journal of Agricultural Science*, vol. V, part IV.

Brunnich's[1] experiments in Australia inform us that the glucoside is never wholly absent, but the quantity gradually diminishes from the first stage of growth to maturity. At the earliest stages of its growth the young plant contains a very large quantity of it and as the plant grows up and nears maturity, the cynogen in the glucoside gradually changes into complex nitrogenous compounds or proteins. In the varieties of *juar* that Brunnich experimented with, he found the quantity of prussic acid to be so great that he recommended that *juar* should only be used when the seed ears are well developed, and that it should not be given to animals which have fasted for some time. Willamon and West[2] have found in America that in about two months the available prussic acid under normal conditions is reduced to a harmless quantity. This is confirmed by the common practice in India which is to allow the cattle to feed upon the plants from the time they are two months old until they are nearly mature. In our experiments in a majority of cases we found the amount of prussic acid to be negligibly small in the case of fully grown plants of about eight weeks old. Willamon and West's experiments also tell us, in what part of the plant most of the glucoside is to be expected. In the first three or four weeks of the plant's life, it is concentrated in the stalks; then it rapidly decreases and disappears from there but apparently persists in the leaves in decreasing percentages until maturity. This explains why the goats which strayed into the same fields as the bullocks at the time when the results were fatal to the latter escaped without any harm, because they ate only the leaves which then contained very little of the glucoside while the bullocks ate the whole plants, leaves, stalks and all and consequently suffered.

It is interesting to note that apparently even under similar conditions of climate and rainfall, the same varieties of *juar* of the same age give widely varying quantities of the poison; that while the crop of one field may be dangerous that of a neighbouring field may be quite innocuous. This is seen from the accompanying table which gives the percentages of prussic acid obtained from the crops of three fields of the village of Khankitta near Sabour. It is possible that this is due to difference in the rates of germination, owing to differences in the moisture contents of the soil in which they were planted. This may give rise to a profitable line of investigation. The samples from each of the fields were collected on the same day and the acid estimated :—

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[1] *Journal of Chemical Society*, vol. 83, page 788.

[2] *Journal of Agricultural Research*, 1915, vol. 4, no. 2, page 179.

Age of the crop when the first sample was taken 1	Date of collecting the sample 2	Number of the field	Per cent. of prussic acid	Grains of prussic acid per lb.
.bout six weeks	3rd July 1915	1	0·0071	0·497
Ditto	Ditto	2	0·0045	0·315
Ditto	Ditto	3	0·0025	0·175
Ditto	5th July 1915	1	0·0066	0·462
Ditto	Ditto	2	0·0025	0·175
Ditto	Ditto	3	0·0017	0·119
Ditto	7th July 1915	2	0·0007	0·049
Ditto	Ditto	3	0·0005	0·035
Ditto	8th July 1915	1	0·0052	0·364

It will be seen that at the age of about six weeks the crops of different fields, apparently similar, could yield materially different amounts of the poison, and though all of them at the time were more or less dangerous, in less than a week, No. 2 and No. 3 had their quantity of poison reduced so much as to be capable of being eaten with impunity. It has not been exactly ascertained under what conditions of cultivation and growth and at what periods, accumulation of the poisonous element in the *juar* becomes greatest. As our attention was drawn to this late in the season when the plants were rapidly losing their poison, no systematic investigation on the subject could be carried out. The American experiments suggest that manuring of a poor soil sometimes results in increasing the amount of the acid in the plant, but certainly there are other factors more important than the soil, which regulate the amount of the poison.

In this season we altogether analysed 25 samples of which seven were from the Sabour Farm and in all cases the farm crops showed considerably less amounts of prussic acid than the outside ones. This was expected as the farm crops this year were very healthy and were growing vigorously.

What should the cultivator do, if owing to persistent unfavourable conditions his fodder crop does not grow up properly and shows a dangerous amount of the poison? It is unlikely that sun-drying will be of much use as *this process will neither break up the glucoside nor kill the enzyme.* In fact it was proved by Brunnich[1] in Australia that sun-drying did not render harmless the poisonous *juar.* As soon as the dry fodder has been soaked in water the enzyme will begin to act upon the glucoside and set the prussic acid free. Instances are not wanting in which the cultivator actually sun-dries a crop which he suspects to be unsafe in the green state, and keeps his dry fodder soaked in water for a considerable time before he feeds his cattle with it. It is just possible that the danger is fairly diminished by this method if sufficient time has been allowed to the enzyme to break up the glucoside entirely, for prussic acid is very volatile and may escape into the air except in so far as it is held in solution by the water present; which at times may be very great. We see therefore that there is a considerable risk in using sun-dried *juar,* firstly, if enough time has not been given to much of the acid to escape, secondly, if there is a good quantity of the acid present in solution after soaking. On the other hand, the process of storing the green fodder in a silo considerably minimizes the danger by breaking up the glucoside, and makes the silage a safe food. This is illustrated by simple experiments conducted in the laboratory at Sabour. The crops of which the prussic acid content had been estimated in the same day were chopped and put under pressure in small drums and were kept in position by lids which were sealed with wax. About three weeks after the lids were opened and the ensilage was analysed and in all cases the quantities of prussic acid obtained were inconsiderably small. That the glucoside was broken up was indicated by distilling the ensilage with water and dilute sulphuric acid, in both of which cases the same amount of prussic acid was obtained. The following tables give the results before and after putting in silo :—

No.	Date of analysis and of putting in silo	Before ensilage Prussic acid per cent	Before ensilage Prussic acid in grains per lb.	REMARKS
1	2	3	4	5
1	14th July 1915 . ..	0·0043	0·30	Dangerous.
2	20th July 1915	0·0040	0·28	Ditto.
3	19th July 1915	0·0081	0·57	Very dangerous.

No	Date of analysis and of opening the silage	After ensilage Prussic acid per cent.	After ensilage Prussic acid in grains per lb.	REMARKS
1	2	3	4	5
1	15th August 1915	0·0001	0·0079	Safe
2	Ditto	Trace	Trace	Do.
3	Ditto	0 0002	0·013	Do.

From the above we see that a crop contained on the 14th July 1915 as much as 0·3 grain of the poison per pound of the crop. Only 16 lb. of the stuff is quite sufficient to supply five grains of the acid, the fatal dose for a country cow, while only a month after putting the crop into the silo, the quantity of available prussic acid was only 0·008 grain per pound and 500 to 600 lb. of this stuff will be required to produce fatal effects in a cow.

It appears therefore clear that even stunted *juar* will be perfectly safe when fed to cattle after storing in a silo for a few weeks. It is hoped that we shall take up further experiments on this next year.

HOW TO BOTTLE FRUITS, VEGETABLES, POULTRY, MILK, MEAT, ETC., FOR DOMESTIC AND COMMERCIAL PURPOSES.*

BY

E L. ROUT,

Inspector of Agriculture, Cuttack.

THE above is the title of a book by ex-Sergeant-Major George Fowler, in which are explained in a simple and lucid manner instructions to preserve fruits, vegetables, and other foods in bottles and jars.

Sergeant-Major Fowler has patented special apparatus and bottles for this purpose. When sterilized in this apparatus the above-mentioned articles can be preserved in the vacuum bottles and jars for an indefinite period.

With the kind permission of Mr. James Taylor, Deputy Commissioner of Angul, who has the apparatus and has started preserving with success garden produce of winter vegetables such as peas and beans and has also preserved snipe, the writer is able to furnish this article, with the hope that others who are interested in this work might take it up.

* * * * *

APPARATUS.

The outfit consists of a bottling apparatus of tin with a thermometer, vacuum bottles, clips and rubber washers or rings, a brush for cleaning the bottles. The thermometer is placed on the side of the apparatus made for holding it in, which is connected with the inside by a passage through which the water comes in and marks the temperature. The apparatus for heating can be used on an ordinary kitchen or oil stove or a gas burner. The following is a brief description. Full details cannot be given as the system is patented, but instructions accompany the apparatus.

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* Reprinted from the *Agricultural Journal of the Dept. of Agri., Bihar and Orissa,* vol. III, part II.

How to sterilize. Put the bottle filled in with fruits or vegetables (cooked or uncooked as the case may be and covered with patent covers with rubber rings) into the apparatus containing water half to three-quarters the height of the bottles. Heat the water slowly to a certain temperature. Now reduce the heating medium and then let the bottles remain in the apparatus at a lower temperature.

If the bottled fruits be intended for commercial purposes the contents of the bottles must not be sterilized at too high a temperature in order to avoid breaking, shrinking and rising of the contents in the bottles which will mar the value of the articles.

Take out the bottles, taking care to keep them on wood or thick paper as the jars might crack in contact with a cold surface such as marble or iron. Keep for 48 hours with the clip or clips on, when they may be taken off or used for other bottles. If the bottles are hermetically sealed the covers should be fast on them, if not then the cause should be rectified and the sterilization repeated.

An unsuccessful sterilization would cause air to get in and ferment the stuff in 18 to 36 hours or become mouldy in a few weeks. If all the germs contained, in the fruit, vegetable or meat, etc., have not been destroyed by sterilization although the bottles are found to be sealed hermetically fermentation will occur and gases collect within the bottles.

The secret of bottling is the thorough sterilization of the articles; on which depends the destruction by heat of every germ in the water and contents within the bottles and the exclusion of air during the process when hermetical closure of the lid is caused by the air being exhausted from the bottles during the heating. To ensure a more perfect vacuum the cover should be on the apparatus.

As both cooked and uncooked articles are preserved the process for each of the methods is slightly different.

For bottling cooked vegetables a high temperature is absolutely necessary. The vegetables must be freshly gathered, prepared, washed in salt and water and cooked (for peas and beans boiling is done for two or three minutes only). Then they are dipped in cold water for a few seconds before being put into the bottles. The bottles must be washed beforehand and put into three-quarter ounce of salt. Fill them with cold water and close them with cover and clip (not using the rubber washers or rings). Add salt to the water in the sterilizing apparatus from 1 lb., 2 lb., 3 lb. according to the size of sterilizing apparatus. After sterilizing for the first time for two hours at a high temperature it should be continued again at an interval of 48 hours at a lower one. The clips should not be removed after 48 hours have elapsed after the second sterilization. Thus the vegetables are bottled and kept for use.

The cost of the apparatus varies from 20*s*. to 50*s*., including a number of bottles, and can be had of Geo. Fowler & Co., 72, Queen's Road, Reading, England.

In India, where there is so often a superfluity of fruit and vegetables at one season of the year and total absence at another, the advantage of bottling surplus produce is evident.

AGRICULTURAL AND VETERINARY OFFICERS ON MILITARY DUTY.

The following Officers of the Agricultural and Veterinary Departments are serving with His Majesty's forces for the period of the war. Any further particulars as to their movements, transfers, etc., will be published here if notified to the editor.

Name	Designation	Particulars regarding service
IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.		
Major J. W. Leather, V.D., F.I.C.	Lately Imperial Agricultural Chemist, Pusa.	Joined the Army in England. A Major in the 3rd Garrison Battalion of the Cheshire Regiment.
J. H. Walton, B.A., B.Sc. ...	Supernumerary Agricultural Bacteriologist, Pusa.	Joined the Indian Army Reserve of Officers on 4th June, 1915, on active service in Mesopotamia.
S. N. Mitra ...	Assistant, Mycological Section, Pusa.	Joined the Military Service on 6th July, 1916, as Indian Warrant Officer, to help Captain C. F. C. Beeson in dealing with the fly nuisance in Mesopotamia.
P. G. Patel ...	Assistant, Pathological Entomological Section, Pusa.	Ditto.
H. N. Sharma, B.A. ...	Ditto ...	Ditto.
L. S. Joseph, G.B.V.C. ..	Veterinary Assistant, Pusa.	Ditto.
P. C. Kar ...	Fieldman, Mycological Section, Pusa.	Ditto.
T. V. V. Subramania Aiyer.	Typist, Entomological Section, Pusa.	Ditto.
P. Narayanan ...	Artist, Publication Branch, Pusa.	Ditto.
D. P. Singh ...	Fieldman, Pathological Entomological Section, Pusa.	Ditto.
IMPERIAL BACTERIOLOGICAL LABORATORY, MUKTESAR.		
R. V. Norris, M.Sc. (Manch.), F.I.C., D.Sc. (London)	Physiological Chemist, Imperial Bacteriological Laboratory, Muktesar.	Joined the Military Department on the 7th of October, 1915; now on, active service in Mesopotamia as Second Lieutenant, I. A. R. O., attached to 112th Mahratta Infantry.
G. H. K. Macalister, M.A., B.C., M.D., D.P.H., M.R.C.S., L.R.C.P.	Pathologist, Imperial Bacteriological Laboratory, Muktesar.	Permitted to apply for active service under the Director-General, Indian Medical Service.

Name	Designation	Particulars regarding service
	BENGAL.	
K. McLean, B.SC. (Edin.) ..	Deputy Director of Agriculture, Dacca.	Has already applied to join the Indian Army Reserve of Officers.
A. D. MacGregor, M.R.C.V.S.	Officiating Superintendent, Indian Civil Veterinary Department.	Posted to Meerut on the 18th February, 1916.
P. J. Kerr, M.R.C.V.S. ...	Superintendent, Indian Civil Veterinary Department.	Serving with Expeditionary Force, D. No. 9, Field Veterinary Section, with effect from 10th July, 1915.
Nalinakshya Basu ...	Veterinary Assistant ..	Serving in 45 Corps, Ambala Cantonment, from 14th May, 1916.
Nagendra Nath Banerjee ..	Ditto ...	Serving in 47 Corps, Lahore Cantonment, from 21st May, 1916.
Bidhu Bhusan Sen ...	Ditto ...	Officer in charge Transport Corps, Lucknow, from 9th May, 1916.
Jitendra Nath Sen Gupta	Ditto	Officer in charge Transport Corps, Lucknow, from 15th May, 1916.
Khagondra Nath Ghosh ..	Ditto ..	Serving in 71 Camel Corps, Ferozepore, from 2nd June, 1916.
Sailendra Lal Sen ...	Ditto ...	Serving in 16 Grantee Camel Corps, Rawalpindi, from 14th June, 1916.
Jagman Singh ..	Ditto ..	Serving in 33 Cavalry Depôt, Saugor, from 20th May, 1916.
	BIHAR AND ORISSA.	
E. J. Woodhouse, M.A., F.L.S.	Economic Botanist and Principal, Sabour Agricultural College.	Joined the Indian Army Reserve of Officers on 14th March, 1915, serving as Lieutenant, Central India Horse, I. E. F. "A."
N. S. McGowan, Diploma in Agriculture (Cantab.)	Professor of Agriculture, Sabour.	Joined the Indian Army Reserve of Officers on 8th March, 1915, served as Second-Lieutenant, 53rd Sikhs, I. E. F. "E." Wounded in action and is in hospital.
	UNITED PROVINCES.	
A. E. Parr, Ph.D., M.A., B.SC., M.S. ...	Deputy Director of Agriculture, Aligarh.	Attached to 11th Cavalry, with effect from 31st August, 1915.
R. D. Fordham ...	Garden Overseer ...	Attached to Indian Expeditionary Force "B," South Africa.
W. S. Smith ...	Ditto ...	Ditto.
T. S. Davies ...	Deputy Superintendent, Indian Civil Veterinary Department.	Private Anglo-Indian Force attached to 1st South Lancashire Regiment, Quetta.
M. Sadiq Husain ...	Veterinary Assistant ...	27th Mule Corps, Peshawar.
Sirdar Jogendra Singh ...	Ditto ...	3rd Skinner's Horse, Bareilly.
Sirdar Kehar Singh ...	Ditto ...	16th Cavalry, Lucknow.

Name	Designation	Particulars regarding service
	United Provinces—contd.	
Sirdar Murat Singh	Veterinary Assistant	34th Prince Albert Victor's Own Poona Horse, Ambala.
Sirdar Niranjan Singh	Ditto	36th Jacob's Horse, Ambala.
M. Bashir Mohamed Khan	Ditto	38th King George's Own Central India Horse, Agar.
Sirdar Nand Singh	Ditto	41st Mule Corps, Sialkot.
M. Abdul Rahman	Ditto	46th Mule Corps, Rawalpindi.
Rai Kedar Nath	Ditto	17th Mule Corps, Bannu.
Munshi Rahat Husain	Ditto	49th Mule Cadre, Lahore.
	PUNJAB.	
H. Southern, M.A.	Deputy Director of Agriculture, Gurdaspur.	Joined the Indian Army Reserve of Officers on the 12th of March, 1915, as Second-Lieutenant, Expeditionary Force. Reported missing in Mesopotamia; unofficially understood to be a prisoner in Turkish hands.
	BOMBAY.	
T. Gilbert, B.A. (Cantab.), Diploma in Agriculture (Cantab.)	Deputy Director of Agriculture, Southern Division, Dharwar.	Has already applied to join the Indian Army Reserve of Officers.
E. S. Farbrother, M.R.C.V.S.	Veterinary Officer attached to the Office of the Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana.	Ditto.
	MADRAS.	
E. Ballard, B.A., F.E.S.	Government Entomologist	Joined the Army in England with effect from 12th February, 1916; serving in Royal Field Artillery.
W. J. D'Costa	Veterinary Inspector	Joined the Army on the 5th of November, 1914; Veterinary Inspector attached to No. 10, Field Veterinary Section, Indian Expeditionary Force "D."
S. C. Jeyasingh Raj	Veterinary Assistant	Served in the Military Department from 25th November, 1914, to 26th January, 1916, when he returned to his original post, being invalided for military duty.
S. R. Lakshman	Ditto	Serving in the Army Department since 11th May, 1916, as Reserve Veterinary Assistant through the Base Transport Officer, Indian Expeditionary Force "D," Makina Masus.
R. Rajamanikkan Pillai	Ditto	Serving as Veterinary Assistant, 20th Duncan Horse, Neemuch, from 1st April, 1916.

Name	Designation	Particulars regarding service
	CENTRAL PROVINCES.	
J. H. Ritchie, M.A., B.SC. ...	Deputy Director of Agriculture, Western Circle, Nagpur.	Has already applied to join the Army.
L. M. Roy ...	Veterinary Inspector ...	35th Scinde Horse, Jubbulpore.
Abdul Rahman ...	Ditto ...	Depôt 29th Lancers, Saugor.
Hemraj Singh ...	Veterinary Assistant ...	2nd (Rawalpindi) Division.
Atta Mahomed Khan ...	Ditto ...	Ditto.
D. Mulla Singh ...	Ditto	Ditto.
M. A. Gafoor Khan ...	Ditto ..	Ditto.
B S. Pardeshi ...	Ditto ..	Ditto.
Mohan Lal Bali ...	Ditto ...	45th Mule Corps, Ambala.
P S. Nair ...	Ditto	54th Camel Corps, Lahore Cantonment.
R. K. Patankar ...	Ditto ..	71st Camel Corps, Ferozepore.
Mirza Kurshed Ali Beg ..	Ditto ...	Ditto.
Qazi Minhazuddin ...	Ditto ...	Not yet posted.
	ASSAM.	
A. G. Birt, B.SC. (Durham)	Deputy Director of Agriculture, Assam.	Joined the Indian Army Reserve of Officers on 30th April, 1915; attached to the North Staffords Regiment and then transferred to the 87th and 82nd Punjabis. Invalided to India temporarily.
U. Kollington ..	Veterinary Assistant ...	Posted to 3rd (Lahore) Divisional Area; Jullunder.
Suresh Chandra Chanda ...	Ditto ..	Attached to 8th (Lucknow) Division, Lucknow.
	BURMA.	
Colonel G. H. Evans, C.I.E., A.D.C., M.R.C.V.S	Superintendent, Civil Veterinary Department.	Served at Rangoon as Port Defence Volunteer from 5th August, 1914, to 15th January, 1915.
Major T. Rennie, M.R.C.V.S.	Second Superintendent, Civil Veterinary Department.	Ditto.

NOTES.

The Preparation of Indigo Paste. Mr. W. A. Davis, the newly appointed Indigo Research Chemist, instituted experiments immediately on his arrival in India to ascertain the best methods of preparing indigo paste of standardised indigotin content and of preserving such paste from bacterial change during storage or transport. He has established that there is no real difficulty in preparing an indigo paste containing approximately 20 per cent. indigotin.

A large scale sample of about ½ ton of uniform indigo paste was prepared at the end of July at the Honourable Mr. D. J. Reid's factory at Belsund and this has been sent to England for the dyers to report upon.

Experiment has shown that probably the best method of rendering the indigo paste stable is to make it slightly alkaline during mixing, by adding about 0·5 per cent. of soda ash. Such paste can be kept for months without showing any development of bacteria or change in composition. There will be no difficulty in preparing homogeneous indigo paste provided a suitable mixing machine is installed in the various factories. We await with interest further developments.—[Editor.]

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The Improvement of Fodder Production in India. The improvement of cattle in India depends largely on a plentiful supply of good fodder. This fact is now being generally recognized and few people are to be found who believe that any real progress can be made in animal production if the food-supply remains, as at present, a limiting factor. The first step in the problem is to feed the animals which already exist. The creation of new types and the improvement of the present breeds by selection are matters of secondary importance in so far as the cultivator is concerned.

The increased production of fodder per unit area is one of the subjects which has been taken up at the Quetta Fruit Experiment Station. In order to get the land into condition for fruit and also to provide a cover-crop between the rows of young trees, various annual fodder plants have been tried. Of these, Persian Clover or *shaftal* (*Trifolium resupinatum*) has proved the most satisfactory. This is a rapidly growing annual which can make use of the winter rains and which gives a large amount of fodder, the last crop of which forms an excellent green manure. An account of the cultivation of this crop and of the preparation of clover hay has already been published.[1] In the present note, the best method, so far discovered, of inducing the crop to give the highest yield per acre is dealt with.

Where the irrigation water is limited, as at Quetta, two means of increasing the duty of water in fodder-growing have been found successful. In the first place, crops like *shaftal* grow faster and need less water if the land is manured in the first instance with farm-yard manure at the rate of about fifteen to twenty tons per acre. The manure apparently increases the aeration of the soil for the benefit of the root-nodules and the effect on the land is not lost in subsequent years. Indeed the growth of the *shaftal* improves the fertility and the second year's crop without manure is better than the first. The second method of making the water go further is by the proper grading of the surface so that the irrigation water flows evenly over the land. In such fields, long narrow *kiaris*, about 300′ × 25′, can be watered easily from one end from a well-made, turfed distributary. The expense and trouble in grading and levelling and in the adoption of the most suitable form of *kiari* is well repaid by the amount of water saved, by the ease with which irrigation can be carried out and in the evenness of the resulting crop.

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[1] Clover and Clover hay, *Bulletin no. 5, Fruit Experiment Station, Quetta*, 1915 (reprinted in the *Agricultural Journal of India*, vol. XI, p. 71, 1916).

During the past season, one of the plots at Quetta which was not in very good condition was put down in *shaftal* in August 1915. The land was manured with farm-yard manure at the rate of about 20 tons per acre and sown with *shaftal* under a thin cover-crop of maize. The area of the plot was 0·6735 acre and five cuts were taken as follows:—

	lb.
1. First cut on October 18th, 1915	1,325
2. Second cut on December 2nd, 1915	4,185
3. Third cut on March 14th, 1916	6,040
4. Fourth cut on April 20th, 1916	12,730
5. Fifth cut on May 19th, 1916	13,737
Total of five cuts ...	38,017

The last crop, which was about the same as the fourth or fifth in weight, was not harvested as this particular plot was kept for seed. Taking this at 12,000 lb., the total of the six cuts would have amounted to 50,017 lb. of green fodder. This works out at 33·15 tons per acre per annum. At eight annas per 100 lb., the year's produce would be worth Rs. 371 per acre, an income obtained with the minimum expenditure of water and resulting in an increase in fertility. This result, which has been confirmed many times at Quetta, indicates the methods which should be adopted in fodder growing on alluvial soils in India—intensive cultivation combined with the minimum expenditure of irrigation water It is probable of course that still heavier manuring would give more cuts and more produce per cut. This has not been tried up to the present as the supply of farm-yard manure in the Quetta valley is limited and there is no point in discovering improved methods which cannot possibly be applied.—[A. HOWARD.]

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A PAPER on "**Scientific Agriculture in India**" by MR. JAMES MACKENNA, M.A., I.C.S., Agricultural Adviser to the Government of India, and Director, Agricultural Research Institute, Pusa, was ead at the meeting of the Royal Society of Arts on 27th April, 1916, by Sir Steyning W. Edgerley, K.C.S.I., K.C.V.O., C.I.E. The paper was much on the lines of his recent monograph on "Agriculture n India." The discussion which followed is published in the

Journal of that Society, Vol. LXIV, No. 3316, June 9, 1916, and is reprinted here as it contains much that is suggestive and illustrates the different points of view which appeal to workers in different lines.

The Chairman (Sir Robert W. Carlyle), in opening the discussion, said the out-turn of rice in India far exceeded that of any country in the world of which we had accurate figures, it being grown over an area which was almost equal to that of Great Britain and Ireland. The production per acre, however, was not at all satisfactory. Compared with countries like Italy and Spain it was very poor, the out-turn in Spain being on the average about five times as great per acre as that in India. In the out-turn of wheat India was second to the United States and Russia, it being grown over an area greater in extent than England. The importation of Indian wheat last year played a great part in preventing an exorbitant rise of prices at a critical period. Here again the production per acre was low, it being barely one-third of the average out-turn in this country. India had the second largest out-turn of cotton in the world, taking second place to the United States. As regards sugarcane, it headed the world. The out-turn per acre was bad, the average in India being about one ton of raw sugar per acre against four times that amount in Java and Hawaii. Thus there was a large margin for improvement in quantity and very often in quality of the crops grown over large areas in India. It was impossible to hope that, within any reasonable number of years, the out-turn of rice or wheat per acre would approach that of Spain or England, but it was possible by scientific agriculture to obtain something very much better than the present meagre results. The author had indicated that it was expected in a few years, owing to one improvement in wheat alone, to make £5,000,000 a year more than at present. That improvement affected only one-sixth of the area under wheat, and it would bring the yield up to about one-half of what it was at present in England. The improvement of agriculture in India was, he believed, the greatest problem now before that country. The Indian agriculturist often did admirable work so far as his means allowed, and by many centuries of experience he iad evolved excellent methods, but their practice could be improved y scientific application. He did not in the least underrate the mportance to India of general industrial development. It was very lesirable that the proportion of the population entirely dependent n the vicissitudes of the seasons should be diminished; but the main staple of India must for all time, so far as he could see, be agriculture. The development of agriculture was not only of vital importance to India from the point of view of the economic welfare of the people, but also of very great importance politically. He believed that under Indian conditions, no political development could be altogether sound which had not at its base a prosperous peasantry capable of understanding and taking its full part in the local administration. It was very fortunate that just at the time when, under Lord Curzon's government, the Agricultural Department was put on its present lines, the great co-operative association movement was also developed. He looked to that movement to produce a profound transformation of Indian social conditions. In the ten years that elapsed since it was first really started, 750,000 members had joined the associations, and he had seen in all parts of India the great increase in the well-being and well-living of villages where they flourished. As the author had pointed out, the two directions in which agriculture would greatly benefit by the movement were, firstly, that it enabled the Agricultural Department to deal with bodies of agriculturists instead of with single cultivators; and, secondly, it enabled the cultivator to borrow money at a rate of interest so low as to enable him to apply capital to the soil with profit. The cultivator had not, so far, availed himself of that privilege to any great extent, but he was sure that there would be rapid development in this direction, and that, owing to the influence of the associations, much more capital would be applied to the soil. India owed a great debt of gratitude to Lord Curzon for his action in regard to agriculture in India. It was very largely owing to the interest that he had taken in the matter, and to his insight into the best methods of furthering it, that the Agricultural Department owed its organization on present lines; and it was also largely due to him that legislation was passed which made co-operative associations possible, and which provided the administrative machinery for stimulating the growth of such associations. It was also under Lord Curzon's *régime* that Sir Colin Scott-Moncrieff's committee was appointed which investigated the possibility of developing irrigation in India, and the result of its labours had been that the amount of work done since then on irrigation had enormously increased. All the time he was a Member of Council he never experienced any difficulty in getting money for any irrigation scheme which was ready. The author had shown in his paper a thorough grasp of the problems with which the Indian Agricultural Department had to deal, and he was sure the country would derive great benefit from his knowledge and capacity during his tenure of office as Agricultural Adviser.

Sir H. Evan M. James, K.C.I.E., C.S.I., thought from his experience, going back fifty years, that very great difficulty would be experienced in getting the conservative agriculturists of India to support the Agricultural Department. Fifty years ago there was a great demand for good Indian cotton in consequence of the American War, and a very distinguished Collector, without any assistance from Government, bought up all the seed which he could procure of the best variety then on the market, called Hinginghat, and forced the ryots to sow it. If any ryot sowed any of the old bad indigenous cotton his crop was pulled up. As a result, in the first year the ryots of that district benefited to an incredible extent, owing to the superior value of the new crop. At the conclusion of the American War interest in Indian cotton on the Liverpool cotton market died out, and an Act which had been passed in Bombay to prevent the adulteration and mixing of cotton was, at the instance of the Bombay merchants, repealed. As a result Indian cotton again became a byword in the market; but a fresh attempt was now being made to revive the cultivation of better staples. Unless, however, the Government of India were prepared to go further than merely introducing good staples, by insisting on their being grown and kept pure, all the very benevolent experiments referred to in the paper were, so previous experience proved, likely to prove abortive. The ryot was a very nice fellow, but he was very conservative; and although undoubtedly a good deal might be done in the way of improving Indian cotton, it was a very long and hard climb uphill to do anything really practical and permanent. Nevertheless, he wished every success to the Department.

Sir Andrew H. L. Fraser, K.C.S.I. (formerly Lieutenant-Governor of Bengal), differed entirely from the remarks made by Sir Evan James, his experience making him an optimist in regard to the future of Indian agriculture. He believed the Indian cultivator was perfectly ready to adopt any method which was actually proved to pay, but it was necessary to show him that something was to be gained by adopting the recommendations of the Department. It was not his experience, especially in later years, that it was difficult to get the ryot to move in the right direction. He was very glad to think that the abominable heresy that an improvement in agriculture could only be obtained through the medium of large capitalist cultivators had now been dispelled. Capital was, of course, necessary; but he would rather give up hope of improvement than see the smaller cultivators swallowed up. The growth year by year of the co-operative system, which had been initiated with so much success, filled him with the greatest belief in the future of Indian agriculture.

Lieutenant-Colonel S. H. Godfrey, C.I.E., Indian Political Department, said that Central India contained many forest tribes which took very reluctantly to agriculture, but which worked very keenly on the development of forest produce. The importance of lac was brought home to him shortly before the war. The Maharaja of Rewah started a lac factory on up-to-date lines in order to develop that very important industry in Central India, and shortly before the war Germans offered to take the whole of its output, which they mixed with cheap German alcohol and exported as varnish. When war broke out the German trade stopped, and the forest tribes were threatened with the elimination of their means of livelihood. Two small States in Central India, in order to rescue their forest tribes, started a scheme to work the factory themselves, which proved successful: and as the markets in Central India for forest produce were limited, a project was submitted to the Government of India to develop a wider ambit for the Native States which had the various forest tribes depending upon them. It was approved by the Government of India, and the Maharajas of Dattia, Panna, and Chhattarpur, the Rajas of Nagod and Maihar, and the Chaube-Jagirdars of the Baghelkhand Political Agency formed a private limited liability company for the development of the work. Shortly after the beginning of the war, Cawnpore was suffering from the want of tannin; the Chiefs employed a scientific expert to report on their produce, and they discovered they possessed some very valuable tannins which were wanted by the Cawnpore factories for the manufacture of army equipment. The company at present deal with lac, tannin, and hides, and the Maharaja Holkar of Indore had established a factory for the manufacture of vegetable dyes for the replacement of aniline dyes. It was the first co-operative State scheme that had been started in India, and had great possibilities. The Central Indian States covered a very large area, from which it might be possible to obtain acetone by dry distillation, and tannin, the latter of which would go far towards supplying a very sore need at present in India, which had to be met by the importation of wattle bark from countries as distant as South Africa. If encouragement were given to the far-sighted and patriotic Indian Chiefs who had risked their money in the concern, it would not only benefit them and their people, but it would go a long way in the scientific development of other States. The Chief Commissioner of the Central Provinces had signified his approval of the scheme by giving to the company large tracts of forest in the northern portions of the Central Provinces on what was practically a profit-sharing basis, which seemed to show that a responsible official had some belief in the development of Central Indian forest produce on scientific lines. His Majesty's Secretary of State for India had sent a tannin expert to India and Burma with instructions to visit the Native State factory at Maihar, in Central India.

Mr. A. Yusuf Ali, I.C.S. (retired), pointed out that the apparent slowness with which agricultural improvements were introduced into India was not due so much to the unreasonable attitude of the ryots or of the people as to certain conditions which made it difficult for them to utilize those processes from which they were convinced they could make money. He was an optimist in regard to the improvement of Indian agriculture in the future, but there were four main difficulties in the way of a greater scientific application of improved methods. Firstly, the ryots had very little capital. Although agricultural co-operation had placed within their means the power of combining together and raising capital, it must be recognized that the co-operative credit movement was in its infancy, and as long as rates of interest of 9 and 12 per cent. prevailed it was impossible to speak of the salvation of agriculture in the matter of borrowing capital. The second need of the Indian agriculturist was a better organization not only in regard to the selection and issue of good seed, but in the selling of the produce. The ryot often received far less than his due for his produce, a larger proportion than was equitable going to the middleman. Thirdly, a more favourable fiscal arrangement was required. Many of the by-products of agriculture were not utilized because the ryot sometimes felt that he was handicapped by the Revenue Law. A great deal had been done in recent years in the Northern Provinces in the way of ensuring to the ryot the benefit of any improvements he made, but he did not have as much protection as he should do. The zemindars were also chary in many cases of investing capital in the land, because they found that, in the periodical settlement, they did not always obtain the results which were contemplated under the Revenue Law. An improved Revenue Law in regard to the partition of land was required. Small holdings were sub-divided to such an extent that holdings of less than one acre existed. Such minute sub-division was not necessary, and it would be found in many cases that they were merely paper sub-divisions. It was necessary to insist that in Revenue partitions the holdings should be compact and not scattered about. The most important necessity of all was improved agricultural education, because in his opinion more capital would be forthcoming, better organization would be available, and better fiscal arrangement would be insisted upon when the agriculturist was better educated. Education—the right sort of education—was the crux of the matter, and he would like to have seen more attention devoted to that subject in the paper.

Sir Frederic S. P. Lely, K.C.S.I., C.I.E., expressed his sense of admiration of the silent but substantial work that had been done in India during the last few years by the Agricultural Department. Compared with earlier days there had been an enormous advance in the manner in which the Government had dealt with the subject.

Mr. J. S. Beresford, C.I.E., said the agricultural conditions in Egypt were very much the same as in India, but there was a great difference in the results obtained and the rentals charged for the land. The difficulty in India was that the cultivator had a very small amount of capital, whereas in Egypt the farmer thought nothing of spending £2 an acre on imported artificial manures, without which the large crops grown could not be produced. He doubly recouped the expenditure by the greater yield. It was impossible for the best production from the land to be obtained without the expenditure of capital, and in any new schemes the Government of India introduced that fact must be borne in mind. It was of interest to mention that since the Agricultural Society of Egypt took in hand the purchase and distribution of artificial manure the consumption had largely increased. The import in 1909 was 21,000 tons, value £178,000 ; while in 1912 it had risen to 70,000 tons, value £668,000. Ninety per cent. of this was nitrate of soda. It was chiefly due to the judicious application of such manure that the high level of production in Egypt was now maintained, for the supply of nitrates from the numerous ruins in the country, on which the people formerly relied, was fast becoming exhausted.

Sir Daniel M. Hamilton, in proposing a hearty vote of thanks to Mr. MacKenna for his admirable paper, thought the last speaker had put his finger on the weak spot in Indian agriculture, *viz.*, the want of finance on the part of the cultivator. It was impossible to build up any industry unless it had a sound system of finance at its foundation. Until the financial question was settled he was afraid Indian agriculture would not advance as rapidly as it should do. He recently read a paper by Mr. Howard calling attention to the fact that the surface soil of India, which was the best part of the soil, was being washed away. Mr. Howard advocated the erection of irrigation bunds to hold up the soil, but such work could not be carried out without money. So far as manures were concerned, he hoped a trial would be made in India of the bacterialized peat discovered by Professor Bottomley of King's College. It had been proved to be a first-class manure, and was, he understood, being manufactured by the Manchester Corporation at £3 a ton. The Government had recently appointed a Commission to study the question of helping Indian industries. Everything possible should, of course, be done to help manufacturers of every kind, but it was often forgotten that the agricultural population of India must always be the great purchasers of manufactured goods, and it therefore seemed to him that one of the ways in which the industrial development of India could best be helped was to develop her agriculture in every possible way.

Sir Frederic W. R. Fryer, K.C.S.I. (late Lieutenant-Governor of Burma), in seconding the motion, fully endorsed Sir Andrew Fraser's statement in regard to the willingness of the ryot to take up any improvement provided he could be convinced that it would pay him to do so. When he was Deputy Commissioner of Hazara he introduced to the sugarcane growers the iron mill made by Mr. Milne, and they adopted it in preference to their wooden mill, as it could be worked with one bullock instead of two; but they would not use the English plough because it necessitated the use of two men and two bullocks, compared with one man and one bullock with the native plough. The cultivators in India were always ready to adopt any improvements that were visible to their personal observation, and he was certain they would be only too pleased to avail themselves of the services of the Agricultural Department. That Department was evidently doing very good work, and the development of agriculture was, as Lord Curzon perceived, one of the first objects to which the Government should devote its attention.

The Chairman, before putting the motion, said that Sir Evan James's scepticism was not altogether unnatural, as cases had occurred in which the cultivators had thrown away the whole advantage they had gained from selection of seed by adulteration on a large scale. The Agricultural Department was now fully alive to that danger, and the organization was so good that it was not likely to occur again. He also thoroughly agreed with Sir Daniel Hamilton's remark that finance was of the greatest importance to agriculture.

The resolution of thanks was then put and carried unanimously.

Sir Steyning Edgerley promised that the vote of thanks which had been so heartily passed should, in due course, be communicated to Mr. MacKenna. The suggestion was made in the paper that organized development was begun in Bombay by Mr. Mollison, but he was sure that gentleman would be the first to acknowledge the labours of a Bombay civilian, the late Mr. Edward Ozanne. He went home to Cirencester in 1881, took his M.R.A.C., and on his return to India was appointed in 1883 the first Director of Agriculture in Bombay. Mr. Ozanne did much spade work between 1883 and 1890, and had successfully dealt with the dairy industry, the number of dairies run on scientific lines having been raised from one to about 800 by 1888, if his memory was correct. He thought it would be found that it was because of Mr. Ozanne's success that the business in Bombay outgrew his powers of dealing with it, and it became possible to convince the Government of India that there was a good case for bringing out Mr. Mollison as Superintendent of Experimental Farms in 1890. It remained only for him to express the thanks of the Committee to Sir Robert Carlyle for kindly presiding that afternoon.

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WE quote the following from an article on **Ayrshires in India** printed in the *North British Agriculturist* and reproduced in the *Journal of Dairying and Dairy Farming in India,* Vol. III, Part II.

"The native cattle of India are almost entirely of the humped type. They are very useful and docile cattle in the main, but they are not heavy milkers. They, however, yield very well in butter-fat, the average as a rule being about 4½ per cent. The problem set before Mr. Smith (Assistant Director of Dairy Farms), and his fellow-workers, therefore, was to find the breed most suitable to cross with these cattle in order to increase quantity, and at the same time not materially reduce the butter-fat yield. The importance of maintaining the butter-fat ratio will be apparent when it is stated that the milk supplied regularly to the Army authorities is expected to average about 5½ per cent. of butter-fat. The way that this is done is to keep attached to each farm a certain number of buffalo cows, and to mix their milk with that of the ordinary cows. The buffalo cow is not a heavy milker, but, like the native Indian cow, she produces a high ratio of butter-fat, the majority indeed giving up to 7½ per cent. A mixture accordingly of two parts cow's milk and one part buffalo's milk usually gives about the desired percentage in the mixed milk. But of course that did not get over the question of increasing the yield of the native cows, and to do this experiments were carried out with Ayrshires, Holsteins, Shorthorns, and one or two other milky breeds. It was interesting to hear from Mr. Smith that of all these the Ayrshire did best. Not only did the imported animals themselves live better than did those of either of the breeds mentioned, but their progeny were generally of a hardier class, while they came consistently more milky. So pleased are the authorities with Ayrshires for this purpose, that they have practically adopted the Ayrshire bull as their crossing animal, some having been imported this year for this purpose alone. We have seen recent photographs of first crosses between Ayrshire bulls and native cows taken on the Government farms in India, and while the animals preserved undoubted indications of their mixed ancestry in slightly dropping ears, and in rather dreamy heads in many cases, they also showed distinct traces of the Ayrshire in their colourings and body formation. Many of the animals are spotted and speckled just as is often seen in a mixed-colour Ayrshire at home, while the drooping quarters of the native cow is nearly always minimized, if it is not entirely eliminated. Mr. Smith is greatly pleased with the result of the cross, and says that already, through its use, it has been possible to increase the average herd yield as compared with the wholly native cow days by something approaching 100 per cent. An interesting feature of the Ayrshire crosses is that there is almost no trace of the hump of the native cow on them. The excrescence seems to disappear at once, while the crosses are very little short of the native cattle in hardiness and ability to stand the often trying heat. Very fair crosses were got from both the Shorthorn and the Holstein in some cases, but the former especially were inclined to go to beef, and the latter were greatly affected by the climate, many of the original importations dying before full use could be got of them."

In this connection the following facts taken from an article on " An Indian Dairy Farm (New Style) " at Bangalore by Rev. Harold Short published in the same issue of the *Journal of Dairying and Dairy Farming in India* will be read with special interest.

" We inspected some of the Ayrshire bulls, which are imported from Scotland yearly—13 arriving last year—also a few from Australia.

" They have worked a wonderful improvement in the Indian cattle. Crossed with the " Hansi " cow from Delhi, the " Saniwal " from the Punjab or the " Sindi " from Sind district there is an upward result in appearance and milk production.

" The highest price for a country cow is £10 to £20. A half-bred Ayrshire goes for £25 to £40.

" On the first cross the unsightly hump on the shoulders of the native cow and the loose hanging flesh from the neck disappear, the horns are shortened and the whole formation of the animal is broadened and deepened. This improvement has been increased to the third generation. We saw an heifer of 18 months—the oldest of the fourth generation. Its products are awaited with great interest. The crosses have calved at 2½ years, but the country cow knows not the joy of maternity until her fourth year. But the greater value of the cross is shown of course in the milk supply.

" The following ' Comparison Statements ' will show the extent of the increase.

" The Saniwal-Ayrshire ' Jill ' has shown the common continued increase with each lactation period—her first giving 7,997 lb., the second 8,031, while the third is proceeding as shown below. The calf is always taken away or weaned after seven days.

Comparison Statement of Yields-fat.

6 of the best half-breds.			6 of the best country-breds.		
No. of Cow.	Yields. lb.	Fat. lb.	No. of Cow.	Yields. lb.	Fat. lb.
133	9,450	418·50	18	4,009	200·11
131	7,409	287·48	28	3,858	180·95
138	6,183	248·00	30	3,710	188·70
141	5,217	245·19	22	3,606	176·40
132	5,377	247·34	31	3,400	170·00
127	4,495	184·50	36	3,154	158·00
TOTAL	38,131	1,631·01	TOTAL	21,737	1,074·16
Average	6,355·17	271·83	Average	3,622·83	179·02

6 of the poorest half-breds.			6 of the poorest country-bred		
No. of Cow.	Yields. lb.	Fat. lb.	No. of Cow.	Yields. lb.	Fat. lb.
290	3,694	166·50	15	1,529	76·45
140	3,628	145·05	7	1,306	62·68
288	3,616	144·66	24	1,233	60·41
135	3,383	137·70	16	1,167	58·35
261	3,349	130·69	21	1,127	52·89
242	2,994	120·00	9	1,047	47·27
TOTAL	20,664	844·60	TOTAL	7,409	358·05
Average	3,444	140·76	Average	1,234·83	59·67

At Pusa also Ayrshire bulls have been imported for crossing with the poorest milkers of the Montgomery herd. The experiments are still in progress but so far as they have gone they promise success.—[EDITOR.]

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Albuminoid Ratio. The albuminoid ratio was first "made' in Germany, and like a good many other German things it was found to be unsuitable for us. The writer long ago pointed out that as these rations were worked out on German animals, with German food, under a German climate, they would require to be greatly modified* to suit us, and he is rather pleased to find that many other people have come round to this way of thinking. The first change was made by the Americans, who found that the German figures were quite wrong for America, and drew up a scale for themselves. The reaction has come to us now, and saner ideas are prevailing. To put the matter generally, it is found that a mixture of foods which shows a ratio of one to ten or one to twelve is quite as good as a more concentrated one, but with great many advantages in favour of the lower grade feeding. Thus, instead of using highly nitrogenous foods, like cotton-cake or bean meal, we can use those of a more starchy nature, and thus middlings, maize, rice, and feeds of that class are quite as efficient, while usually costing less in the market. As a matter of fact there is a rough correspondence between the market prices and richness in nitrogen in foods as there is in manures; cakes are nitrogenous, while such things as maize, rice, middlings, etc., are not. All this in practice means that we shall get as good result on a less forcing ratio than we have hitherto used, with a corresponding improvement in the health of the animals. We shall have less milk fever among cows, for instance, on a more starchy food than on one rich in albuminoids. We have taken a long time to find these things out, and probably much harm has been done in past years by following a scheme of using foods in too concentrated a fashion; but it is not too late to alter and improve matters, and to use more of the "weaker" and cheaper foods and less of the "stronger" and dearer ones.—[PRIMROSE McCONNELL. *Journal of Dairying and Dairy Farming in India, Vol. II, Part III.*]

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* Kellner's famous stock work on the subject "The Scientific Feeding of Animals" wa always held by the best British agriculturists to be totally inaccurate regarding its treatmen of roots in rations. The truth is, the German never has and never will rightly understan what we mean by 'roots' as he can only deal in sugar-beet and vegetables which hardly rar as cattle food.—[W. S.]

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IN the *Mysore Economic Journal* for May, 1916, there is an interesting note on **Industrial Co-operative Societies** by Mr. Alfred Chatterton. While it is true that in the new development of the material resources of India the industrial co-operative society may possibly play a very important part it must be noted that before this can come about a very large amount of experimental work will have to be done. Hitherto, so far as is known, industrial co-operative societies have not met with any large measure of success, and the work they have undertaken is more of a commercial than industrial character. Before starting an industrial co-operative society it is necessary that the ground should be prepared by preliminary training, and when machinery is to be set up efforts should be made to enlist the co-operation of surrounding villages so that there may be no shortage of raw material. In view of the amount of training and supervision which these societies require it is not advisable to attempt to increase their number at all rapidly. This will be clear from the description of the two Industrial Co-operative Societies established in the villages of Bannoor and Sabbenahalli in Mysore. These have worked sufficiently long to afford some indication of the difficulties which will have to be overcome before they are completely successful.

The Bannoor Co-operative Society possesses a rice mill and a sugarcane-crushing plant capable of turning out jaggery. The capital of the Society is Rs. 22,500 divided into 150 shares of Rs. 150 each (all of which have been subscribed and on each share Rs. 10 have been paid up). The Mysore Government have advanced the Society a sum of Rs. 20,000 with which to purchase machinery, and the plant has been erected by the Department of Industries. Mr. Chatterton reports that just before the sugar mill was completed the ryots in Bannoor managed to get all their cane milled on the old lines as they were disturbed by rumours regarding the probable success of the new plant. Only 30 maunds of jaggery was made here, but this small quantity has sufficed to dissipate their fears regarding the quality and quantity of the *gur* that can be turned out by the plant. The rice mill with a nominal capacity of 7 cwt. of clean rice per hour has up to date worked for 528½ hours and has turned out 1,672 *khandies* of clean rice, the milling revenue being Rs. 1,457-11-6. As there was not enough paddy forthcoming the mill was not worked continuously, and even on working days was not worked full time. The people store paddy in their godowns and sell it at favourable times. They believe that paddy when stored keeps much better than rice and so they are unwilling to have it milled. This state of things is, however, changing. The mill is being worked by the Department and the members of the Co-operative Society hardly realize that it is their own property and that if it is not a success they will have to make good the loss. This will, however, bring them to a realization of the importance of its working full time.

At Sabbenahalli the Co-operative Society has established a cane-crushing plant consisting of a 14 b. h. p. suction gas engine and a 12" by 18" roller mill with sufficient evaporating pans of the new type to turn out 250 maunds of jaggery a day. It worked throughout the whole of the last cane-crushing season and successfully dealt with the whole crop in the village. But as the crop in the village was a poor one there was not enough work for the cane-crushing plant. A larger area has been put down under the crop, and if the current season proves favourable it should do extremely well. Here again the members do not realize the nature of the undertaking upon which they have entered. While they appreciate the advantages the question of repayment of the loan does not seriously trouble them.

We quote the following remarks of Mr. Chatterton:—

"At Bannoor, the people are now beginning to appreciate the advantages of having a rice mill in their midst, and at Sabbenahalli, from the outset they made full use of the cane-crushing plant; but the whole work has so far been done by the departmental agency, and it seems likely that it will be some years before the Co-operative Societies will be able to take over the plants and work them themselves. Our object at the present time is to foster a sense of ownership with its responsibility and to associate and train the local people to manage the undertaking. Ultimate success seems assured, but the goal is a long way off, and it is not easy to devise methods by which departmental control and responsibility may be gradually relinquished."—[EDITOR.]

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The Goat as a Source of Milk.—In the *Journal of the Board of Agriculture*, London, Vol. XXII, No. 7, there is a very practical and useful note on this subject.

In view of the small initial expenditure entailed in the purchase of a goat, minimum housing accommodation required, and the limited amount of cost of food and other maintenance charges and; above all, the extraordinary hardiness and adaptability of this animal, goats can be profitably kept to supply milk for domestic use and it is for domestic rather than business purposes that the goat is here recommended. There is a widespread belief that goats' milk always possesses a peculiar flavour. This flavour may possibly be caused by the goat feeding on certain herbs, but it is far more probably due to a want of cleanliness of the utensils employed. The rich creamy taste of the goat's milk renders it more attractive to the palate than cow's milk. It is easily digested by children and especially infants. It is also far less likely to contain tubercle bacilli of animal origin.

In selecting a goat the purchaser should look to the following points :—

"The body should be long and fairly deep, although if the latter point is very marked, it is probable that the animal is aged. It is important that the ribs should be well sprung, whilst a long head and a slender neck are generally considered to indicate a good milking strain. If the goat is dry the quality of the udder cannot be ascertained, but if in milk the udder should be carefully examined. It should not only be of good size, but soft and pliable, and the teats should be long and pointed, as they are then most easily handled. It is always desirable for the purchaser to see the goat he is about to buy milked at least once before coming to a decision. This is necessary not merely to ascertain the actual yield, but to find out if the animal stands quietly while being milked. A goat purchased in milk should not be less than two years old or over five. The age can be detected by examining the teeth."

It is stated that in England there are at present five breeds of goats, two of which belong to what may be called the common kind and three to the improved varieties. The common type are English and Irish goats, the superior breeds being the Toggenburg of Swiss origin (the only strictly pure breed in Britain) and the Anglo-Nubian and the crosses "Swiss" and "Anglo-Swiss." The last cross is considered to be probably the best all-round goat in Britain.

Goats breed when very young, often have two, sometimes three, kids at one birth and often produce young twice a year. The period of gestation is about 21 weeks or roughly five months. If a family keeps three goats they may justly look for a regular supply of milk all the year round. Signs of the coming into season are in some cases very transient. They consist in frequent bleating, a constant shaking of the tail, a turgid condition of the vulva, loss of appetite and restlessness and a temporary diminution in the milk-yield if the goat is in milk. This condition will last from one to three days.

If the improvement of the stock for milk production is the object in view, it is essential to secure the services of a male bred from a good milker or still better having "milking blood" on both sides of his parentage. The kids will then be worth rearing. Otherwise it is better to destroy male kids and use all the milk from the goat for domestic purposes. It seldom pays to rear male kids. A well-bred male kid may however be retained if it is not possible to secure near at hand one for service whenever required. The repulsive odour and objectionable habits of he-goats are well known.

In the feeding of goats absolute cleanliness of food and of the receptacle to hold it is required. The use of a metal pail is therefore advocated. Another essential is variety of food as the goat will give up eating if a change is not provided. Economy in feeding should certainly be looked to. From their kid stage goats should be encouraged to eat all vegetable waste from the kitchen or house-hold scraps. Except poisonous shrubs there is hardly any plant which is not acceptable to the goat. Goats are active and industrious feeders.

For the first three or four days after kidding the milk should be fed to the kid as it is not then suitable for human consumption. After that time the goat can be milked twice or thrice daily. Milking should be carried out at regular intervals and the udder completely emptied each time. The more quickly the milking is done the better; otherwise, the goat will become impatient and restless. The last drops or 'strippings' are always the richest. In England an average goat will give at its flush three pints a day:

The total milk-yield in the case of an average goat is about 67 gallons a year, while in the case of better milkers it may go up to 80 to 90 gallons.

In India goats are successfully bred by professional shepherds in districts with moderate or light rainfall and light naturally well-drained soils. A considerable variety of natural herbage in the tract and clean ground to graze each day are essential for raising large flocks of goats and sheep. In small numbers goats are reared in this country and their value as milk-producers appreciated, but there is room for improvement, and goat-keeping for domestic purposes might be extended with great advantage in many districts where it is hardly known.—[EDITOR.]

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IN view of the scantiness of information available as to the relative values of various concentrated foods for dairy cattle in India, the work carried out at Lyallpur, under the direction of Mr. Roberts, Professor of Agriculture in connection with the **feeding of cotton cake** (undecorticated) **to dairy cattle,** and published in the *Journal of Dairying and Dairy Farming in India*, Vol. II, Part III, is of considerable interest. Gram is the usual concentrated food used in the Punjab. Cotton seed is chiefly used in that province for feeding buffaloes and milch animals and also to some extent working animals. For the past few years cotton seed cake has been manufactured in Lahore; its selling price is about Rs. 1-8 per maund f. o. r. Lahore. Eight cows were selected, and divided into two groups of four each. The two groups were nearly alike in total daily milk-yield and in length of lactation period. One group was fed with cotton cake, the other with gram. The cotton cake supplied was always first broken and then moistened for three hours before feeding. Small quantities of the cake were given to start with and this was mixed with gram. The proportion of cake was increased daily and that of gram decreased, until at the end of eight or nine days the gram was entirely replaced. A little trouble was experienced with one cow who refused to eat the cake at first unless mixed with gram. Gradually this was overcome, and later she consumed the cake greedily. At the end of the second month the total increase in live weight in both the groups was found to be practically equal.

As regards quantity and quality of the milk the advantage after some time was found to be on the side of cotton cake rather than on gram.

It was found that 23 seers of cotton cake had the same nutritive value as 16 seers of gram. The feeding of cotton cake is very economical. Cotton cake costs Rs. 1-11 per maund in Lyallpur while gram runs at about Rs. 3-8 per maund. This will mean considerable saving to a dairyman keeping a herd of say 20 cows.

It appears therefore that cotton cake can be safely and economically fed to dairy cows in milk. It is possible that this food may not be suitable for cows nearing calving time, but further experience on this point is necessary.—[EDITOR.]

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WE print the following extract from a leaflet on "**Some Uses of Prickly-pear**" published by the Department of Agriculture, Madras.

"In parts of Coimbatore district, prickly-pear is used after decomposition and composting as a manure for dry land crops such as *cumbu*, *cholam*, dry *ragi* and garden crops like *ragi*, chillies, tobacco, wheat, plantains, sugar-cane, etc. This is, however, not resorted to by all. In many cases it is prickly-pear growing in corners of their fields or extending from outside into the fields that is cleared and composted by way of disposal. A few ryots compost prickly-pear especially when it is abundantly available near at hand; but this is not followed as much as it might be.

"Ryots, however, have taken up to the practice of carting to their fields the earth which accumulates under prickly-pear bushes for improving their lands. In tank bunds and 'porambokes,' nothing is paid for the earth itself, and the cost is only two annas per cart-load (when the distance to be carted is about half a mile), for clearing the prickly-pear to get at the earth beneath, digging the earth, loading and carting it to the fields. The price per cart is becoming higher gradually owing to the increased wages. The soil under the prickly-pear bushes is of high manurial value as it is very largely composed of leaf mould and other organic matter blown in by the agency of wind. Prickly-pear itself contains more than 60 per cent. of organic matter (Dr. Leather's analysis) and if such a substance is composted with the rich soil found under these bushes the manurial value will certainly be enhanced. Many of our soils are deficient in organic matter and if a compost of prickly-pear and the soil found under it is made and applied, the result will be beneficial. By composting prickly-pear, ryots not only obtain manure but get rid of this pest which is at present a nuisance in many respects.

"The following methods may be adopted for composting :—

(1) A trench 3′ to 4′ deep and 6′ broad of any required length may be dug and kept ready during the interval between the first and second monsoons. During rainy days when the ryots have not got busy work, prickly-pear may be cut, removed, and filled in the trench and covered with soil that has been removed in digging it. The top of the trench will sink after some days owing to the decay of the stuff and at this stage the soil from under the removed bushes may be dug and thrown on the top. In places having good rainfall, this will make a good compost within one year. If the thorns have not decomposed thoroughly, this may be left for another year when the thorns also will decompose.

(2) In regions of scanty rainfall, prickly-pear may be removed and heaped up in convenient mounds and allowed to dry up during seasons when ryots have enough leisure at their disposal. Dried bushes, grasses, and other rubbish procurable in the vicinity may be spread over the heaps and set fire to. The thorny substance is partially burnt. At this stage the earth removed from under the bushes or from lands close by should be spread all over the heap which can then be left for some years until decomposition is complete. In three or four years, this will be fit for being carted to fields.

(3) If space is not available for the above, circular construction similar to those used for grinding *chunam* should be made. Th prickly-pear is then thrown into this pit and ground by a stone grinder just as *chunam* is ground. Owing to the large amount o water in the stems the plant, when the stuff is ground, is converte into a jelly-like substance within half an hour and the whole mas

can be removed by *mammuties* and carried to places where compost is to be made. If this is filled in pits or covered with some earth, decomposition will easily set in. The thorns also will not stand erect but will lie flat and the nuisance they cause will be much reduced. In this case the manure will be ready within six to eight months.

"Prickly-pear can also be used to serve other useful purposes than the one above referred to. The water obtained after boiling prickly-pear for some time can be used as a drier in whitewashes. An ordinary pot or *chatti* is filled with prickly-pear cut into small pieces; as much water as the pot will hold is then added. The whole is boiled for about three hours and stirred during the process. When cool, the liquid is strained and added to separately prepared white or colour wash in the proportion of 1 to 150 or 160. Whitewash or colour wash treated in this way becomes fast and does not rub off easily. In Indian houses this fast colour is a great advantage as it does not soil the clothing or body when the newly whitewashed walls are touched."

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THERE has been a revival on the Bombay side of the question of utilizing prickly-pear as fodder for cattle. There is nothing in the discussion that has not been dealt with many times in these columns. In Australia where it has been tried for cattle feeding they seem to be coming to the conclusion that the best thing to be done with this pest is to destroy it utterly, and then if it can be used to any advantage well and good, if not it is a good riddance of bad rubbish. A process has been discovered there of **treating prickly-pear with arsenious trichloride**, by which extensive areas have been completely cleared. In the course of the operations it has been discovered that a big percentage of potash can be obtained from the ash of the prickly-pear, and preparations are being made to enable Australia to supplant Germany in the supply of potash.—(*Madras Mail.*)

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THE Fourth Annual Meeting of the **Indian Science Congress** will be held at Bangalore on the 10th, 11th, 12th, and 13th January

1917. H. H. the Maharaja of Mysore has consented to be Patron of the meeting whilst Sir Alfred Bourne, K.C.I.E., F.R.S., will be the President. The following Sectional Presidents have been appointed :—Mr. J. MacKenna, I.C.S. (Pusa), Agriculture and Applied Chemistry; the Rev. D. Mackichan (Bombay), Physics; Dr. Ziauddin Ahmad, C.I.E. (Aligarh), Mathematics; Mr. K. Ramunni Menon (Madras), Zoology; Mr. C. S. Middlemiss, C.I.E (Calcutta), Geology; Dr. J. L. Simonsen (Madras), Chemistry.

REVIEWS.

Indian Journal of Economics, Vol. I, Part I, January 1916.—Issued quarterly by the University of Allahabad, Department of Economics. Subscription, Rs. 12 per annum. Single copy, Rs. 4.

We extend a welcome, belated but none-the-less sincere, to the excellent Journal which issues under the editorship of Prof. H. Stanley Jevons. The name is one which will recall many memories of early struggles with formal philosophical conundrums.

In his editorial foreword Prof. Jevons states that the issue of the Journal has been undertaken with a three-fold purpose—(1) to provide a medium for the publication of articles on Indian Economics by authors of standing ; (2) to furnish a convenient and compact vehicle of publication for original investigations made by the staff of the Economics Department of the Allahabad University ; and (3) to disseminate information about the economic activities of other countries.

The first issue is delightfully Indian in its subjects. It opens with an article on " Agricultural Banks in India " by that enthusiast Mr. D. E. Wacha ; and although we must record our emphatic dissent from his opinions we cannot but admit the force and vigour with which Mr. Wacha states his case. Personally we would rather pin our faith to what Mr. Wacha is pleased to call " these new-fangled societies, "—*i.e.*, Co-operative Societies—than to an institution like the Agricultural Bank of Egypt ; and we are firmly convinced that not only the financial but also the moral regeneration of India lies in the development of these co-operative societies. Easy money means easy debt. It is quite simple to liquidate a man's debts : it is a slower process to educate him and develop his character so that he will not fall into debt again. But of course ere are two sides to this as to all other questions; and Mr. Wacha ertainly puts his case well.

A short paper on the Indian cotton trade by Prof. Todd is llowed by a most stimulating paper by our old friend Mr. W. H. oreland on the Ain-i-Akbari—a possible base line for the economic istory of modern India. The figures relate to the latter part o he sixteenth century and the writer considers that if the figure he Ain-i-Akbari contains can be used they will furnish a rea starting point for the modern economic history of the country. W hope that this article will act as a stimulus to some of our India students of economics to examine critically the available statistic of India before the British Government began to tabulate them They would command great interest.

The other articles in this issue are an interesting compariso of the Southern States of America with India as regards economic conditions by Prof. Sam Higginbottom; a paper on Indian factory legislation by Mr. S. H. Fremantle, I.C.S.; and one on the teaching of economics by the editor. A set of able reviews of books on economic and kindred subjects completes the issue.

We congratulate the editor on the form and quality of his first number and we look forward with much interest to future issues. The awakening of an interest in economics, especially the economics of agriculture, is a most healthy sign of progress and we trust that under the stimulus of Prof. Jevons and his staff the circle of Indian workers in this most fascinating subject will be widely extended. —[J. M.]

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Bengal Economic Journal.—Edited by Prof. C. J. HAMILTON and Prof. J. C. COYAJEE. Published by Macmillan & Co., Ltd., Calcutta, Bombay, Madras, and London. Subscription Rs. 10 per annum.

WE have received the first number of the *Bengal Economic Journal* edited by Professors Hamilton and Coyajee, and we take this opportunity of welcoming a Journal which supplies a long felt want.

Economics are all too neglected in India. A little closer study of them in the past would have saved much money, notably in banking circles.

We would especially note the article on "The Moratorium" by Prof. Coyajee, and criticism of the "Report on Co-operation in India" by B. Abdy Collins. There is a cold, calm, hard common sense about them both which is most comforting in these days of lightning finance of the mushroom order. In the article on the Moratorium we would draw special attention to the statement made that "Both France and Germany have been preparing for decades against the present crisis; and yet when the time for action came, the former took refuge under the most comprehensive scheme of moratoria ever devised while the latter adopted a policy of the most lavish extension of loans, and, even then, could not avoid a certain number of moratoria. At least since the Agadir incident the German banks, by Imperial command, have striven to make their resources more liquid and concentrated at home. In France, too, constant preparations have been made both by the Bank of France and by the other great banks for a rapid financial mobilization. A high authority, H. Germain, could say on behalf of the other banks that they were ready for *any* event, if the Bank of France was ready. The present war dissipated all this confidence in a moment." The constant preparations made were of no avail; for the closing of the stock exchange rendered the most liquid securities of all banks unrealizable.

Such a fact should give those connected with finance furiously to think and we hope equally furiously to overhaul their financial machinery and see whether it would be capable of working under such a strain in a land where it is difficult to keep down rumours and to inspire confidence even far away from the actual crisis, and it must not be forgotten that as we increase facility of communication and exchange throughout the world we render the financial failure of one country likely to be felt more and more widely by all others. The days of splendid isolation are gone for ever.

Mr. Collins' remarks on auditors hit a weak spot and their truth is driven home by his reference to Indian banking circles.

In order that co-operative societies may be able to command the confidence of investors it is very necessary that the system of audit and the persons by whom this audit is conducted should be above suspicion. While there is no objection in principle to societies being audited by non-Government auditors licensed by the Registrar—in fact non-official audit is to be preferred as it is less likely to develop into a routine—it must be understood that the audit staff should not depend for their pay and prospects directly upon Central Banks and Unions. It is on these and other ground that an Audit Federation somewhat on the lines of the Provincia Audit Union of the Central Provinces has much to commend it.

What is wanted in the auditor is local knowledge and sympathy backed by no personal interest in the matter. It has often been said that the manager of the local branch bank in an English agricultura town is the finest agricultural accounts auditor existing. He know when to be stern and strict and when not to allow undue strictnes to interfere with necessary progress because his knowledge enable him to value assets correctly and the valuing of agricultural asset requires a special knowledge which cannot be found in any outsider

The progress of co-operative societies will render it necessary to train auditors in this line, if they are not to be hindered in thei progress, not so much to audit accounts—many can do that—but to put the true value on the assets. His article is of the greates interest and we hope he will write again. There is still plenty in the report awaiting criticism.—[W. S.]

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A Manual of Elementary Botany for India. By Rai Bahadur K. RANGA ACHARI, M.A., L.T., Madras. Printed and published by the Superintendent, Government Press, Madras. Price Rs. 2.

UNTIL quite recently the professor or teacher of elementary botany in India was dependent on text-books written in Europe or America. Such books, while excellent in dealing with principles, are ill adapted for use in India, since the plants and conditions described in them are in many cases not found here. There exists a very considerable technical literature regarding Indian botany *but the digest of that material suitable for a text-book has been* made in only a few cases. The work under review is the most recent of these attempts to utilize local material for the elucidation of botanical principles and it certainly is the best work of its kind so far produced. The book has been printed and published by the Government Press, Madras, and the letterpress, plates, and general get-up are excellent. Considering this, the price is amazingly low—a most desirable thing, for Indian students will not, as a rule, indulge in expensive books.'

The manual is avowedly elementary, and the writer confines his attention to the flowering plants. The morphology of many local examples is fully explained. The most striking parts of the book are those dealing with the anatomy of plants, illustrated by really convincing original microphotographs. Apart from the value to the student of the morphological and anatomical portions, they are also of value to the teacher in showing him what material to use for the demonstration of special points, and it is hoped that the very excellence of the book on its descriptive side will deter no student or teacher from going direct to the living plant.

As the book does not pretend to be a manual of laboratory practice, detailed directions are not given regarding microscopical technique and the designing of physiological experiments. At the same time it is desirable to develop the physiological section of the book, making it more precise, and dealing at greater length with the evidence on which the necessarily dogmatic text-book statements are based, *e. g.*, in the case of the study of plant nutrition by water cultures (p. 133), and in the case of the statement (p. 185) "it is obvious, that for the production of offsprings, the fusion of the male and female cells is essential even in the case of plants."

In reading through the book the scientific purist may take exception to many minor points, such as the mixing of classification systems by dividing plants into spermaphyta and cryptogams (p. 1), the calling of the web of a girder its flange (p. 91), and the statement that "groups of plants that give a distinctive feature to a locality are called 'formations'" (p. 330); but these detract little from its value as a text-book. A complete and exhaustive index is however a necessity.

One problem confronting the author of such a book is to produce a work which shall be useful in all parts of this great continent. How far this problem has been solved can only be determined by trial, and we strongly recommend all professors and teachers of elementary botany to make use of the book and communicate their views to the author of the book.

It is to be hoped that in time text-books for India will be produced dealing with more advanced botany and especially with the cryptogams. Is it too much to hope that a group of professors and teachers may collaborate to produce a composite advanced manual for India on the lines of Strasburger's *Text-book of Botany* ?

Manuals of applied botany are also required giving summaries of the great mass of valuable Indian work done in plant breeding, mycology, and economic botany generally.—(W. B.)

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The Year-book of the United States Department of Agriculture, 1915.—(Pages 616, Plates 75, Figs. 13, etc. Washington, Government Printing Office.)

THIS publication is perhaps one of the mirrors in which the economic progress of the world is most comprehensively reflected.

There are two outstanding features in the 1915 issue. One is, of course, the effect of the European war—reflected in the changes in acreage, value, and quantities exported, of crops; the other is the large number of articles which deal with voluntary organization among agriculturists.

With a record yield of wheat in 1914 and an increase of over 25 per cent. in the price, 37 per cent. of the crop grown in the States was exported; and the 1915 crop, estimated at over a thousand million bushels, again beat all records. On the other hand, a cotton crop 14 per cent. greater than that of 1913 was worth one-third less to American farmers, and a decrease of 15 per cent. in the acreage for 1915 coincided with a falling off of 20 per cent. in the yield per acre.

The prospect of a rise in the prices of American exports as compared with those of imports, as a result of the transfer of capital from Europe during the war, should be encouraging to the growers of long-stapled cotton in India.

Seven of the 24 articles in the Year-book relate to co-operative organization of one kind or another, and give a very comprehensive idea of the importance of this movement and the extent to which it can be fostered even in such a home of individualism as the United States.

The movement embraces almost every conceivable aspect of rural economy, from the breeding of livestock and the marketing of crops to dairying and the improvement of roads; and includes such diverse organizations as boys' and girls' clubs for specific purposes, local 'small community' clubs, and mutual insurance companies. In an article on "How the Department of Agriculture promotes Organization in Rural Life," Mr. C. W. Thompson, Specialist in Rural Organization, says:—

"Reviewing all the various types of organization through which the Department of Agriculture seeks to promote the welfare of the farmer, it may be noted that in every case the organization is undertaken for some specific purpose, and that that purpose is one which can better be accomplished through concerted effort than through individual action alone. This represents the general policy of the Department with regard to organization among farmers. The Department does not encourage organization simply for the sake of organization, nor does it encourage the indiscriminate formation of organizations for any and every object whatsoever; for some objects may be accomplished efficiently and economically by individuals working each by himself.

"For the accomplishment of those objects which clearly call for co-operative or co-ordinated action on the part of the farmers, the Department encourages a more efficient use of existing organizations, where that is practicable, either by inducing them to take up new lines of activity, or by pointing out efficient methods of carrying on the activities for which they were originally formed. Where new associations are needed, the Department endeavours to secure organizations which are as simple in form as possible, and to keep in the foreground the object of the organization rather than the organization itself."

It is difficult to imagine a more effective way of counteracting the centralizing tendencies of Governments whether autocratic or socialistic, than by voluntary organization on these principles; and reading these articles one catches a glimpse of a future when the activities of Governments may be merged in the public recognition and inspection of voluntary associations, not merely organized for agriculture, commerce, or education, but co-ordinated for readily accessible justice, for police, and, on a basis wider and more solid than has ever hitherto been possible, for military defence of the common weal—the ultimate prerogative of centralized authority.—[A.C.D.]

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Note on Cattle of the Bombay Presidency.—Bulletin No. 75 of the Department of Agriculture, Bombay. Printed at the Yeravada Prison Press, Poona. Price As. 3½ or 4*d*.

THIS Bulletin deals with cattle of the Bombay Presidency excluding Sind. The author, Rao Sahib Kelkar, is a senior officer of the Department who is intimately acquainted with the local conditions of his province. The province is divided into nine tracts and in each the conditions are briefly noted on. In the chapters on Breeds of Cattle, Dairy Industry, and Feeding of Cattle, the author has included a large amount of original local information acquired by personal contact with the cattle-owners. Original information of this nature is always valuable, and unless such is put on record agricultural departments stand to lose much valuable material when members leave the service.

A plan is given for the treatment of 50 acres, to yield green fodder continuously throughout the year. This problem would, of course, have to be separately worked out for each tract. It will prove a very fruitful source of work and one which will have to be seriously taken in hand in all parts of India.—[G. S. H.]

Dairying and Dairy Breeds (*In Marathi*).—BY B. K. GHARE, Pages 14+195. Printed by Mahadeo Sakharam Date at the Vaidic Patrika Press. Price Re. 1.

THE author of this book, Mr. Bhaskar Kashinath Ghare, L. Ag., Agricultural Lecturer at the Cawnpore Agricultural College, brought out a small pamphlet in Marathi under the title of "Milk and Dairying" three years ago, and the book under review is a much enlarged edition of the same with certain additions and fuller treatment of the subjects dealt with therein. As far as we are aware this is the first book of its kind in Marathi treating so fully and simply about the importance of milk in all its aspects and the care of animals, etc., and is a welcome addition to the literature on technical subjects in that language. The author seems to have made every endeavour to avoid English scientific terms or their high-sounding coined equivalents of Sanskrit origin in his work, and this has tended to make the subject-matter easy of comprehension.

In the introduction written for this book by Mr. M. G. Phatak, L. Ag., the importance of pure milk and its production has been shown in a concise but impressive way, and it conveys to the mind of the reader a vivid idea of dairying and animal husbandry as it should be practised in India.

We find the whole book packed with very useful facts which have been well put together. But we also notice some statements which either require modification or amplification.

The process of secretion of milk as described in Chapter I is too brief to be easily followed and should be made clear enough.

The author, in his enthusiasm for extolling the virtues of milk has gone the length of attributing to it the power of curing formidable diseases like consumption. We do not doubt the digestibility and nutritive value of pure milk diet in certain diseases, but we cannot agree with him in endowing it with curative powers over this of all the diseases.

In Chapter IV the slope recommended for gutters in the byre for the passage of urine and dung is 6 inches to every 20 feet o length. This is unnecessarily steep and we believe that a slope of 3 inches to 25 feet of length ought to suffice for this purpose.

In describing circulation of blood the lungs are said to be a part of the circulatory system which is not the case. They belong to the respiratory apparatus.

Chapter VII regarding common ailments of cattle is very meagrely treated. In this chapter under the heading of "Hoven" it is recommended by way of treatment to force the animal to run about. This is a dangerous practice.

In Chapter VIII on cattle-breeding the description of breeds lacks precision, and the illustration used to represent the Jafferabadi buffalo is not a typical one. All the illustrations of cattle are rather indistinct.

Thore are many typographical mistakes both in figures and words throughout the book, and the author would do well to attend to these and the points referred to above when bringing out another edition of the book.

The book on the whole is very useful and informative and as such it will, we hope, be appreciated by the Marathi-reading public. —[J. H.]

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM 1ST FEBRUARY TO 31ST JULY, 1916.

GENERAL AGRICULTURE.

No.	Title	Author	Where published
1	The *Agricultural Journal of India*, Vol. XI, Part II. Price Rs. 2; annual subscription Rs. 6.	Issued from the Agricultural Research Institute, Pusa.	Messrs. Thacker, Spink & Co., Calcutta.
2	Special Indian Science Congress number of the *Agricultural Journal of India*. Price Rs. 2 or 3*s*.	Ditto	Ditto
3	Report on the Progress of Agriculture in India for 1914-15. Price As. 5 or 6*d*.	Agricultural Adviser to the Government of India, Pusa.	Government Printing India, Calcutta.
4	Proceedings of the Board of Agriculture in India, held at Pusa on the 7th February, 1916, and following days (with Appendices). Price Re. 1-2 or 1*s*. 9*d*.	Issued from the Agricultural Research Institute, Pusa.	Ditto.
5	Soil Aeration in Agriculture, Bulletin No. 61 of the Pusa Agricultural Research Institute. Price As. 4 or 5*d*.	A. Howard, C.I.E., M.A., Imperial Economic Botanist.	Ditto.
6	Annual Report of the Board of Scientific Advice for India for the year 1914-15. Price R. 1 or 1*s*. 6*d*.	Issued by the Board of Scientific Advice for India.	Ditto.
7	Agricultural Statistics of India for 1913-14, Vols. I and II. Price Rs. 2-8 and R. 1 respectively.	Issued by the Department of Statistics, India, Calcutta.	Ditto.
8	Estimates of area and yield of principal crops in India for 1914-15. Price As. 4.	Ditto	Ditto.
9	Season and Crop Report of Bengal for 1915-16. Price R. 1 or 1*s*. 6*d*.	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Boo Depôt, Calcutta.
10	Groundnut.—Leaflet No. 1 of 1916, of the Bengal Department of Agriculture (for free distribution).	F. Smith, B.Sc., Deputy Director of Agriculture, Bengal.	Obtainable from the D partmen of Agricultur Bengal.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
11	Agricultural Statistics of Bengal for 1914-15. Price As. 12 or 1*s.* 3*d.*	Issued by the Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.
12	Season and Crop Report, Bihar and Orissa for 1915-16. Price As. 6 or 6*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
13	Leaflet on the use of *Dhaincha* ..	Ditto ..	Ditto.
14	*Agricultural Journal* (published half yearly), Vol. III, Part II. Subscription R. 1 per annum.	Ditto .	Ditto.
15	Agricultural Statistics of Bihar and Orissa for 1914-15.	Ditto ...	Ditto.
16	Report on the Benares Agricultural Station for the year ending 30th June, 1915. Price As. 6 or 6*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
17	Report on the Government Horticultural Gardens, Lucknow, for the year ending 31st March, 1916. Price As. 4 or 6*d.*	Ditto ..	Ditto.
18	Report on the Government Botanical Gardens, Saharanpur, for the year ending 31st March, 1916. Price As. 4 or 6*d.*	Ditto ...	Ditto.
19	A note on the improvement of the indigenous methods of *Gur* and Sugar making in the United Provinces and a report on the Government Experimental Sugar Factory, Nawabganj, Bareilly District. Price As. 4 or 4*d.*	W. Hulme, Sugar Engineer Expert to the Government of India, and R. P. Sanghi, Sugar Chemist, Experimental Factory, Nawabganj.	Ditto.
20	Year Book of the Punjab Agricultural Department for 1916. Price Re. 1-4.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
21	Prospectus of the Punjab Agricultural College, Lyallpur (for free distribution).	Ditto ...	Ditto.
22	Expenses and Profits of cultivators in the Punjab (for free distribution).	Ditto ..	Ditto.
23	Cotton Survey Report of the Gujranwalla District (for free distribution).		Ditto.
24	Cotton Survey Report of the Jhang District (for free distribution).	Ditto ...	Ditto.
25	Lawrence Gardens' Report. Price Anna 1 or 1*d.*	Ditto .	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
26	Annual Report of the Department of Agriculture, Bombay, for 1914-15. Price As. 12 or 1*s.* 2*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
27	Annual Report of the Sukkur Agricultural Station for 1914-15. Price As. 5-6 or 6*d.*	Ditto ...	Ditto.
28	Annual Report of the Surat Agricultural Station for 1914-15. Price Rs. 1-10 or 2*s.* 6*d.*	Ditto ...	Ditto.
29	Annual Report of the Dohad Agricultural Station for 1914-15. Price As. 10-9 or 1*s.*	Ditto ...	Ditto.
30	Annual Report of the Dhulia Agricultural Station for 1914-15. Price As. 10-6 or 1*s.*	Ditto .	Ditto.
31	Annual Report of the Jalgaon Agricultural Station for 1914-15. Price As. 9-9 or 11*d.*	Ditto ...	Ditto
32	Annual Report of the Nadiad Agricultural Station for 1914-15. Price As 13 or 1*s.* 3*d.*	Ditto ...	Ditto.
33	Annual Report of the Gokak Canal Agricultural Station for 1914-15. Price As. 11-3 or 1*s.* 1*d.*	Ditto ..	Ditto.
34	Annual Report of the Gadag Agricultural Station for 1914-15. Price As. 9-9 or 11*d.*	Ditto ...	Ditto
35	Annual Report of the Dharwar Agricultural Station for 1914-15. Price As. 13-9 or 1*s.* 4*d.*	Ditto ..	Ditto.
36	Annual Report of the Alibag Agricultural Station for 1914-15. Price As. 10-6 or 1*s.*	Ditto ..	Ditto.
37	Annual Report of the Ratnagiri Agricultural Station for 1914-15. Price As. 9-6 or 11*d.*	Ditto ...	Ditto.
38	Annual Report of the Mirpurkhas Agricultural Station for 1914-15. Price As. 5-3 or 6*d.*	Ditto ...	Ditto.
39	Annual Report of the Landhi Agricultural Station for 1914-15. Price As. 4-6 or 5*d.*	Ditto ...	Ditto.
40	Annual Report of the Larkhana Agricultural Station for 1914-15. Price As. 4-6 or 5*d.*	Ditto ...	Ditto.
41	Annual Report of the Manjri Agricultural Station for 1914-15. Price As. 14 or 1*s.* 4*d.*	Ditto ...	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
42	Annual Report of the Experimental plots in Satara and Sholapur Districts for 1914-15. Price As. 1-6 or 2*d*.	Issued by the Department of Agriculture, Bombay.	Government Central P Bombay.
43	Annual Report of the Ganeshkhind Botanical Gardens for 1914-15. Price As. 4 or 5*d*.	Ditto ..	Ditto.
44	Annual Report of the Agricultural College Dairy, Kirkee, for 1914-15. Price As. 4 or 5*d*.	Ditto ..	Ditto.
45	Annual Report of the Poona Agricultural College Farm for 1914-15. Price Re. 1-1 or 1*s*. 7*d*.	Ditto ..	Ditto.
46	Annual Report on the Experimental work of the Economic Botanist and his staff for 1914-15. Price As. 2 or 3*d*.	Ditto .	Ditto.
47	Report on the Committee appointed to consider measures for the improvement of the milk supply in large cities in the Bombay Presidency. Price As. 3 or 3*d*.	G. F. Keatinge, C.I.E., I.C.S., President of the Committee.	Ditto.
48	Note on Cattle of the Bombay Presidency. Bulletin No. 75 of 1915 of the Department of Agriculture, Bombay. Price As. 3-6 or 4*d*.	Rao Sahib G. K. Kelkar.	Ditto.
49	Artificial Manures—Experiments with their value for crops in Western India. Bulletin No. 76 of 1915 of the Department of Agriculture, Bombay. Price As. 4 or 5*d*.	Harold H. Mann, D.Sc., and S. R. Paranjpe, B.Sc.	Ditto.
50	Experience of Kalli Chitti Abhoye Naidu of Pulla, Kistna District, on Green Manure. Leaflet No. 1 of 1916 of the Department of Agriculture, Madras.	Chitti Abhoye Naidu ...	Government Press, Madı
51	Some Uses of Prickly Pear. Leaflet No. 2 of 1916 of the Department of Agriculture, Madras.	J. Chelva Ranga Raju ...	Ditto.
52	Groundnut cultivation in the Upland Taluks of the Godavari District. Leaflet No. 3 of 1916 of the Department of Agriculture, Madras.	D. Balakrishna Murthi ..	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	General Agriculture—contd.		
53	Pulichai, Mailam, or Jari Cotton in Tinnevelly and Ramnad Districts. Leaflet No. 4 of 1916 of the Madras Department of Agriculture.	G. A. D. Stuart, I.C.S. ..	Government Press, Madra
54	The *Agricultural and Co-operative Gazette* (Monthly) from February to July, 1916. Price As. 2 per issue.	Issued by the Department of Agriculture, Central Provinces and Berar.	Shalom Press, Nagpur.
55	A Handbook of Agricultural Leaflets (in Hindi). Price As. 3-6.	G. Evans, M.A., Deputy Director of Agriculture, Northern Circle, Jubbulpur.	George Printing Press Jubbulpur.
56	Season and Crop Report of Burma for the year ending 30th June, 1916. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Burma.	Government Printing Burma, Rangoon.
57	Report of the Mandalay Agricultural Station (including Natywagon Sub-Station) for the year 1914-15. Price As. 6 or 7*d.*	Ditto ...	Ditto.
58	Report of the Padu Agricultural Station for the year 1914-15. Price As. 2 or 2*d.*	Ditto ...	Ditto.
59	Report of the Buggi Experimental Plot for the year 1914-15. Price As. 2 or 2*d.*	Ditto ..	Ditto.
60	Burma Agricultural Calendar for 1916-17 (in Burmese).	Ditto ...	Ditto.
61	Minutes of the 8th Half Yearly Conference of the Agricultural Department held at Maymyo on the 17th and 18th April, 1916.	Ditto ..	Ditto.
62	Sugarcane Cultivation—Cultivators' Leaflet No. 46 of the Department of Agriculture, Burma.	A. Mackerral, M.A., B.Sc., Deputy Director of Agriculture, Southern Circle, Burma.	Ditto.
63	Report on the Season and Crops of Assam for 1915-16. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printin Office, Shillong.
64	Summary of Remarks on the Kharif Crops of the North-West Frontier Province for 1915. Price As. 4 or 4*d.*	Issued by the Department of Agriculture, North-West Frontier Province.	.....
65	The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual Subscription, R. 1.	Madras Agricultural Students' Union.	Literary Sun Press, Coin batore
66	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Scientific Department of the Indian Tea Association, Calcutta.	Catholic Orphan Pres Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

General Agriculture—concld.

No.		Author	Where published
67	The *Journal of Dairying and Dairy Farming in India.* (Issued quarterly).	Published by the Indian Committee of the Dairy Education Association.	Messrs. Thacker, Spink & Co., Calcutta.
68	*Poona Agricultural College Magazine* (Quarterly). Annual Subscription, Rs. 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
	Report on the Working of the Government Gardens and Parks in Mysore for 1914-15.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
70	Report on the Operations of the Department of Agriculture and Fisheries, Travancore for 1914-15.	Issued by the Department of Agriculture, Travancore.	Government Press, Trivandrum.

AGRICULTURAL CHEMISTRY.

No.		Author	Where published
71	The Gases of Swamp Rice Soils, Part III. A Hydrogen-oxidizing Bacterium from these Soils. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 4. Price As. 12 or 1*s.*	W. H. Harrison, M.SC., Government Agricultural Chemist, Madras, and P. A. Subramania Aiyer, B.A., Assistant to the Government Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
72	Some Factors affecting the cooking of Dholl (*Cajanus indicus*). Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 5. Price R. 1 or 1*s.* 6*d.*	B. Viswanath, T. Lakshman Row, B.A., and P. A. Raghunathaswami Ayyangar, B.A., Assistants to the Government Agricultural Chemist, Madras.	Ditto.
73	Studies in the Chemistry and Physiology of the leaves of the Betel vine (*Piper betle*) and of the Commercial bleaching of betel-vine leaves. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. IV, No. 7. Price R. 1 or 1*s.* 6*d.*	Harold H. Mann, D.SC., Agricultural Chemist to the Government of Bombay, and V. G. Patwardhan, B.AG.	Ditto.
74	Note on the Soil of the Experimental Farms. Bulletin No. 13 of 1916 of the Department of Agriculture, Burma. Price As. 2 or 2*d.*	F. J. Warth, M.SC., Agricultural Chemist, Burma.	Government Printing, Burma, Rangoon.
75	A Soil Survey of the Guntur Delta. Bulletin No. 70 of the Department of Agriculture, Madras. Price Re. 1-8 or 2*s* 3*d.*	W. H. Harrison, M.SC., and B. Vishwanath.	Government Press, Madras.

BOTANY.

No.		Author	Where published
76	Some Varieties of Indian Gram (*Cicer arietinum*, L.). Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 6. Price R. 1 or 1*s.* 6*d.*	Albert Howard, C.I.E., M.A.; Gabrielle L. C. Howard, M.A.; and Abdur Rahman Khan, Second Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
	Botany—contd.		
77	Studies in Indian Oil-seeds, No. 1, Safflower and Mustard. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VII, No. 7. Price Re. 1-8 or 2*s*. 6*d*.	Albert Howard, C.I.E., M.A.; Gabrielle L. C. Howard, M.A.; and Abdur Rahman Khan, Second Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
78	Studies in Indian Sugarcanes, No. 2. Sugarcane Seedlings, including some correlations between Morphological Characters and Sucrose in the Juice. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. VIII, No. 3. Price Rs. 3 or 4*s*. 3*d*.	C. A. Barber, SC.D. (Cantab.), Government Sugarcane Expert, Madras.	Ditto.
79	An Account of the Genus *Capsicum* grown in the Central Provinces and Berar. Bulletin No. 5 of the Central Provinces Department of Agriculture (only 50 copies available for sale).	K. P. Shrivastava, Assistant Economic Botanist, Central Provinces.	Government Press, Central Provinces, Nagpur.
	MYCOLOGY.		
80	Black Thread Disease of *Hevea* in Burma. Bulletin No. 14 of 1916 of the Department of Agriculture, Burma. Price As. 2 or 2*d*.	J. F. Dastur, B.SC., 1st Assistant to the Imperial Mycologist, Pusa.	Government Printing, Burma, Rangoon.
	ENTOMOLOGY.		
81	One Hundred Notes on Indian Insects. Bulletin No. 59 of the Agricultural Research Institute Pusa. Price As. 8 or 9*d*.	T. Bainbrigge Fletcher, F.L.S., F.E.S., F.Z.S., Imperial Entomologist.	Government Printing, India, Calcutta.
82	First Report on the Experiments carried out at Pusa to improve the Mulberry Silk Industry, compiled under the direction of the Imperial Entomologist. Bulletin No. 48 of the Agricultural Research Institute, Pusa. Price As. 6 or 7*d*. (Translated into Bengali.)	M. N. De, Sericultural Assistant, Pusa.	India Press, Calcutta.
83	The Mango Shoot-borer. Leaflet No. 2 of 1916 of the Bengal Department of Agriculture (for free distribution).	P. C. Sen, Entomological Collector, Bengal.	Obtainable from the Department of Agriculture, Bengal.
	VETERINARY.		
84	Statistics compiled by the Government of India from the Reports of Provincial Civil Veterinary Departments for 1914-15.	Issued by the Government of India, Revenue and Agriculture Department.	Government Printing, India, Calcutta.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title	Author	Where published
		Veterinary—contd.	
85	Some Diseases of Cattle in India, 1916. A handbook for stock owners, (revised, 4th edition.) Price As. 8 or 9*d*.	Major G. K. Walker, C.I.E., Superintendent, Civil Veterinary Department, Bombay.	Government Printing, India, Calcutta.
86	Annual Report of the Civil Veterinary Department, Bihar and Orissa for 1915-16.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
87	Annual Report of the Civil Veterinary Department, United Provinces, for the year ending 31st March, 1916.	Issued by the Department of Agriculture, United Provinces.	Government Press, Allahabad.
88	Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1914-15. Price Re. 1-2 or 1*s*. 9*d*.	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
89	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1915-16. Price R. 1 1*s*. 6*d*.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
90	Annual Report of the Government Stud Farm at Kunigal, Mysore, for 1914-15.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

TO BE HAD FROM

THE OFFICE OF THE AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA, PUSA, BIHAR,

and from the following Agents :—

(1) THACKER, SPINK & CO., CALCUTTA.
(2) W. NEWMAN & CO., CALCUTTA.
(3) RAI M. C. SARKAR BAHADUR & SONS, CALCUTTA.
(4) HIGGINBOTHAMS, LTD., MADRAS.
(5) THOMPSON & CO., MADRAS.
(6) D. B. TARAPOREVALA SONS & CO., BOMBAY.
(7) THACKER & CO., LTD., BOMBAY.
(8) SUNDER PANDURUNG, BOMBAY.
(9) RAI SAHIB M. GULAB SINGH & SONS, LAHORE.
(10) MANAGER, EDUCATIONAL BOOK DEPOT, NAGPUR.

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